

## LA-UR-21-21648

Approved for public release; distribution is unlimited.

Title: Vaccines and Viral Variation Will Fischer LANL Theoretical Biology

Author(s): Del Mauro, Diana  
Fischer, William Mclean

Intended for: Frontiers in Science public talk, Feb. 24

Issued: 2021-02-19

---

**Disclaimer:**

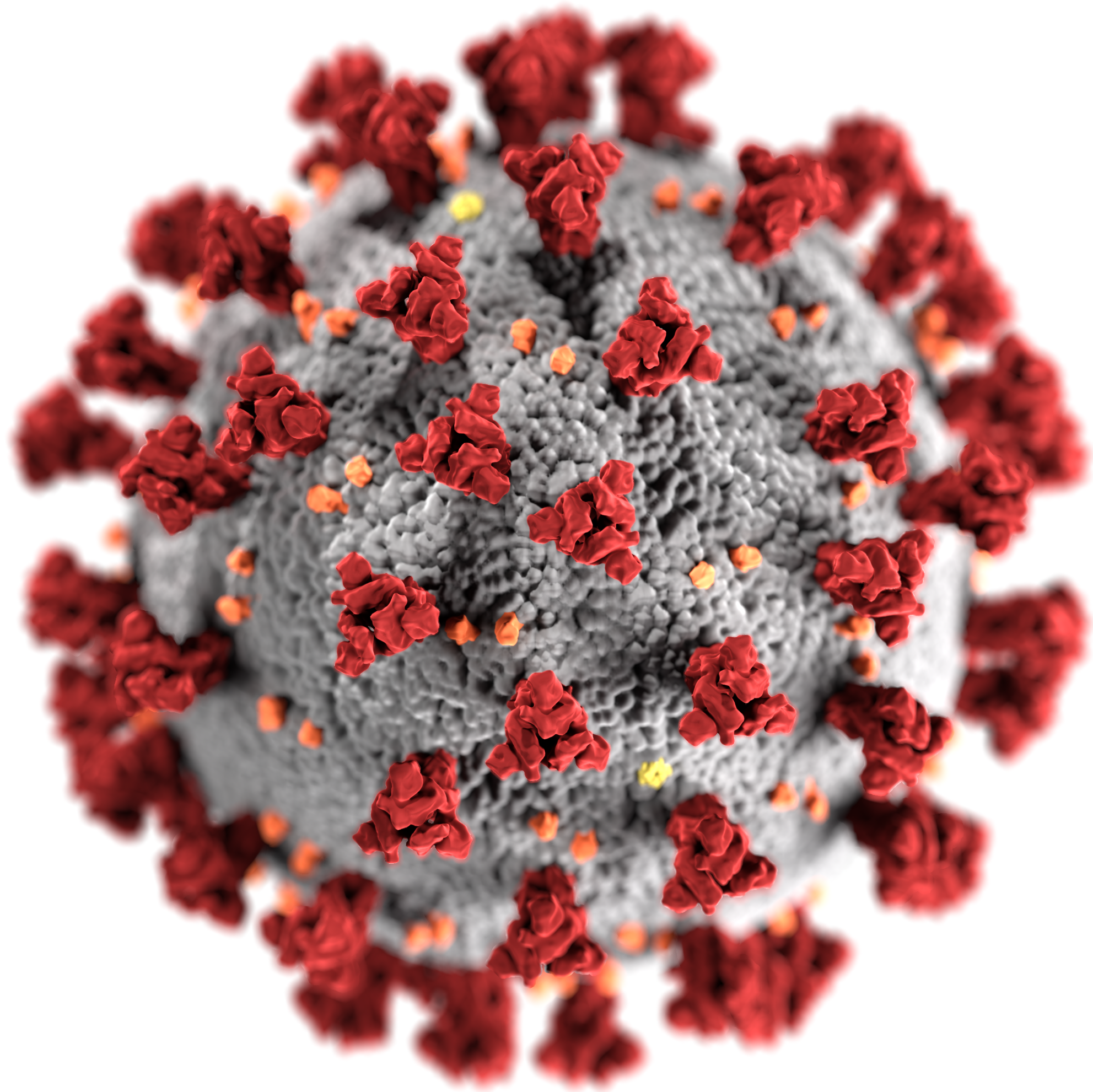
Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by Triad National Security, LLC for the National Nuclear Security Administration of U.S. Department of Energy under contract 89233218CNA000001. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

# Vaccines and Viral Variation

Will Fischer  
LANL Theoretical Biology

# Different views of the Viral Spike



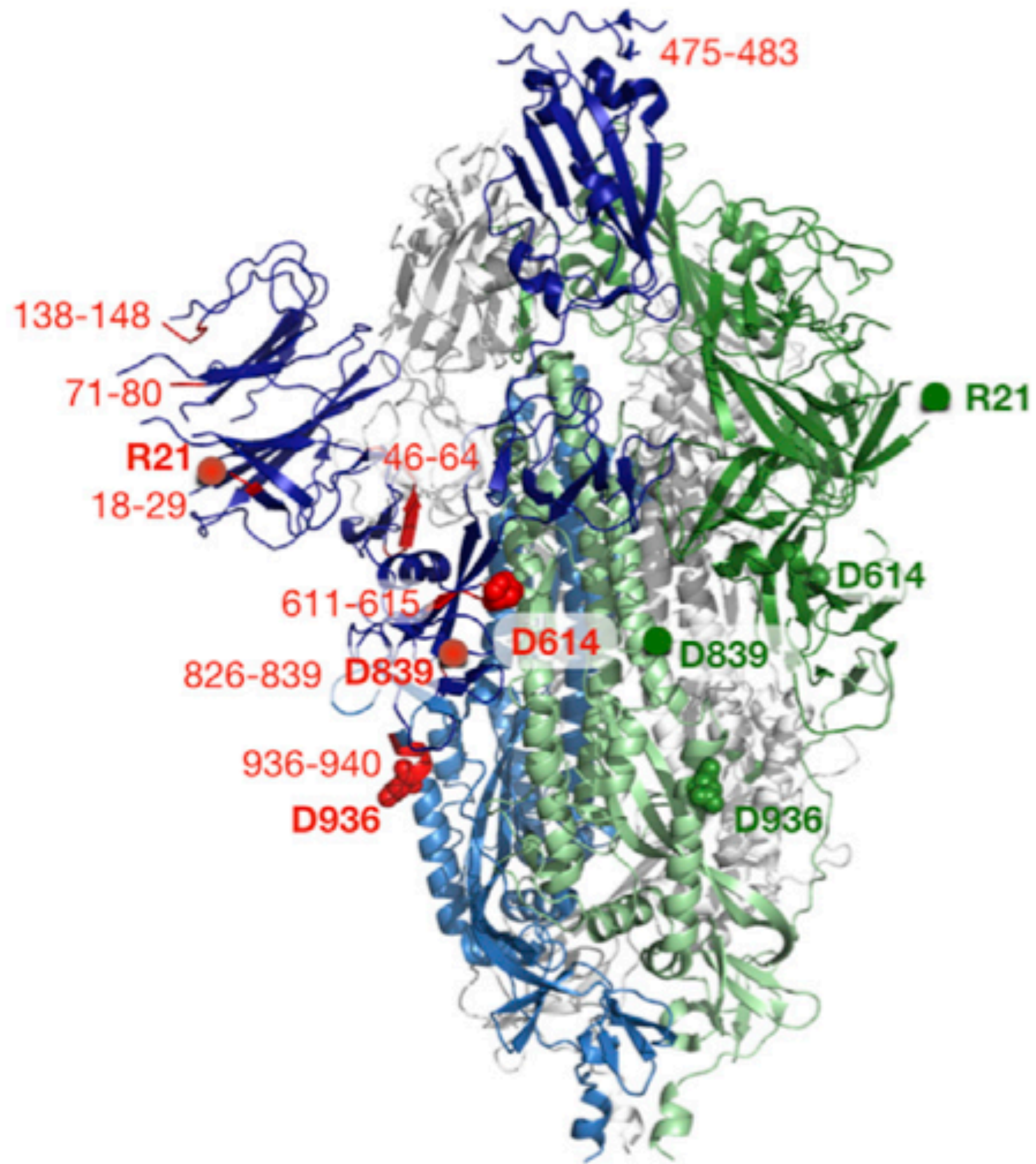






VIRUS







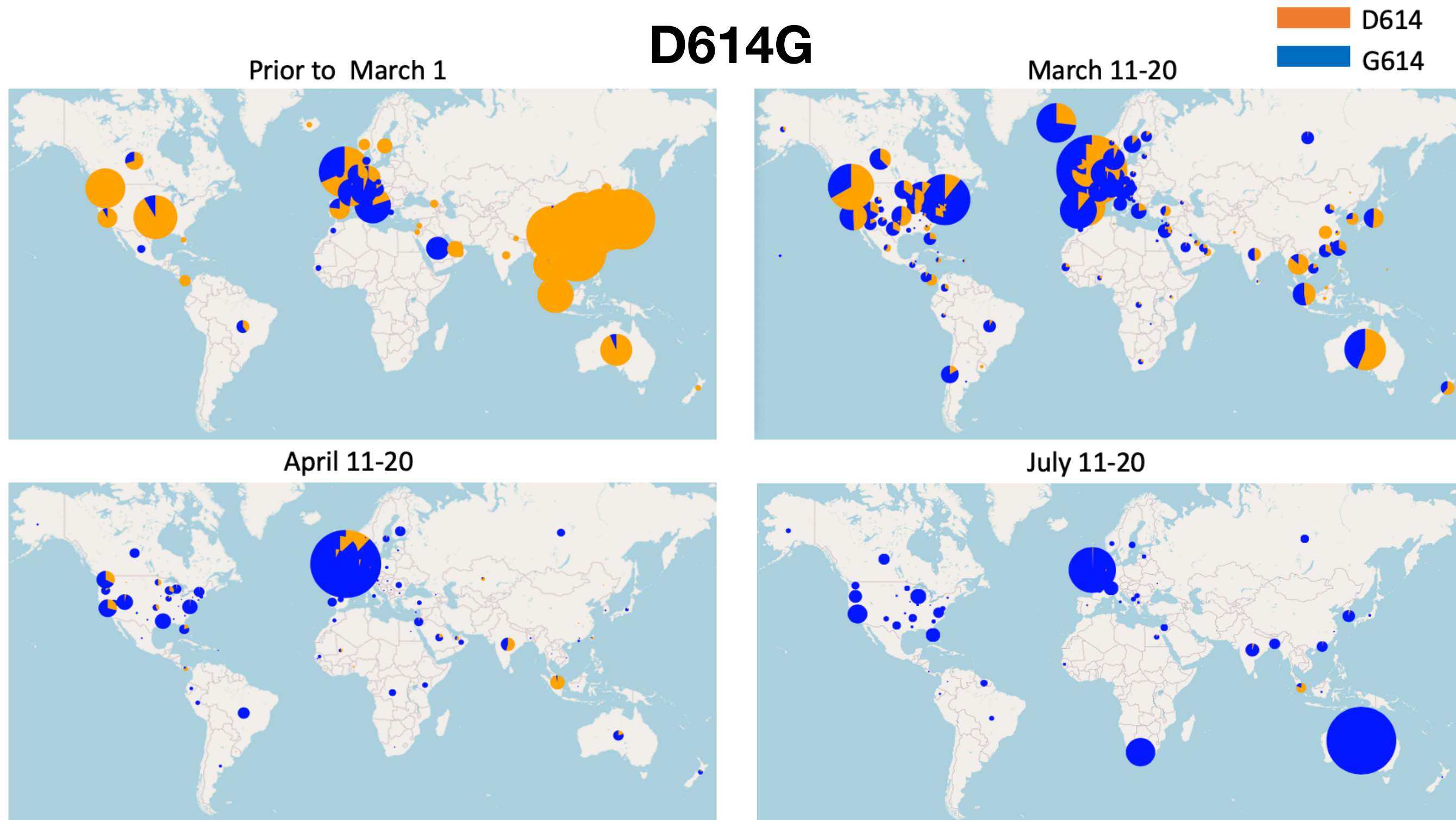
**In March and April of  
2020, a SARS-CoV-2  
variant with a single  
spike mutation ...**

**... took over the world**



# Two fast-growing variants

# Two fast-growing variants

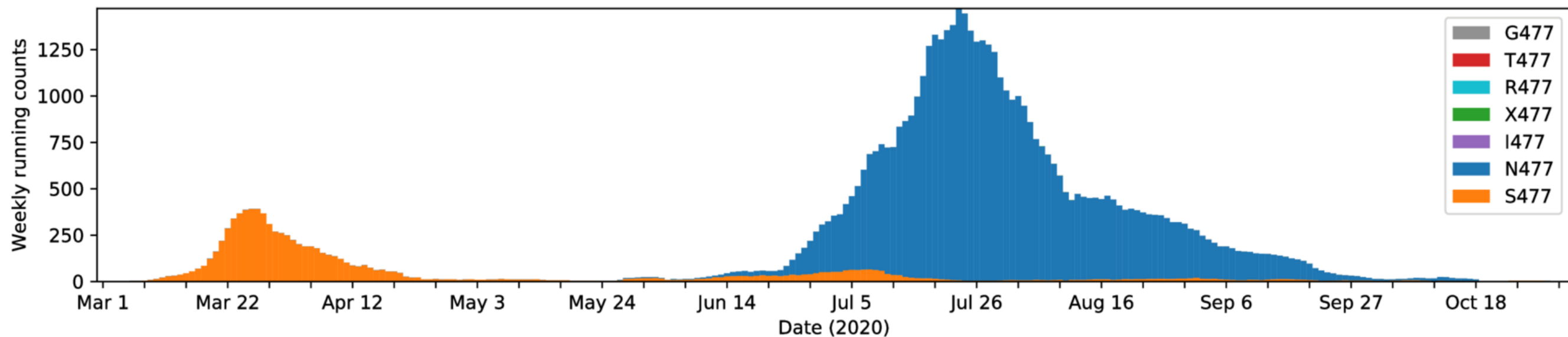


Bette Korber, James Theiler, Werner Abfalterer

# Two fast-growing variants

**S477V**

SPIKE: Australia



**Bette Korber, James Theiler, Werner Abfalterer**

# Mutations accumulate randomly



# Mutations accumulate randomly

---

# Mutations accumulate randomly

---



# Mutations accumulate randomly



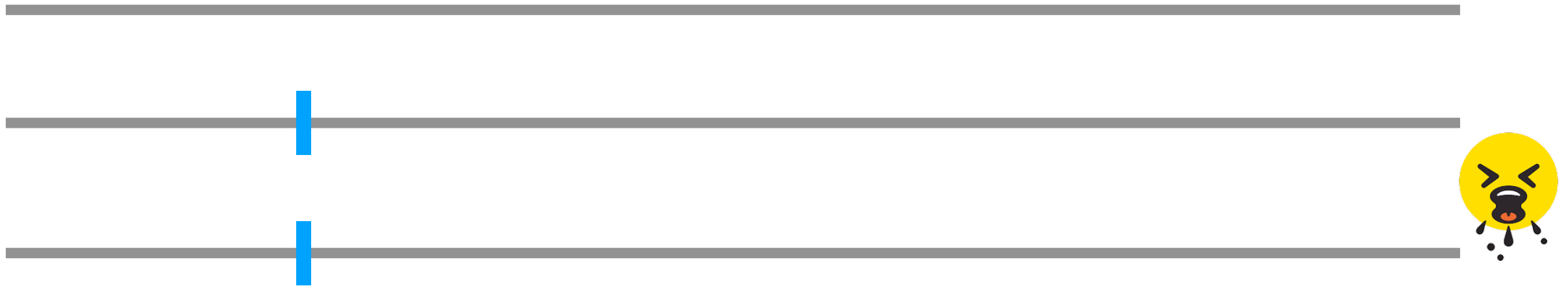
# Mutations accumulate randomly



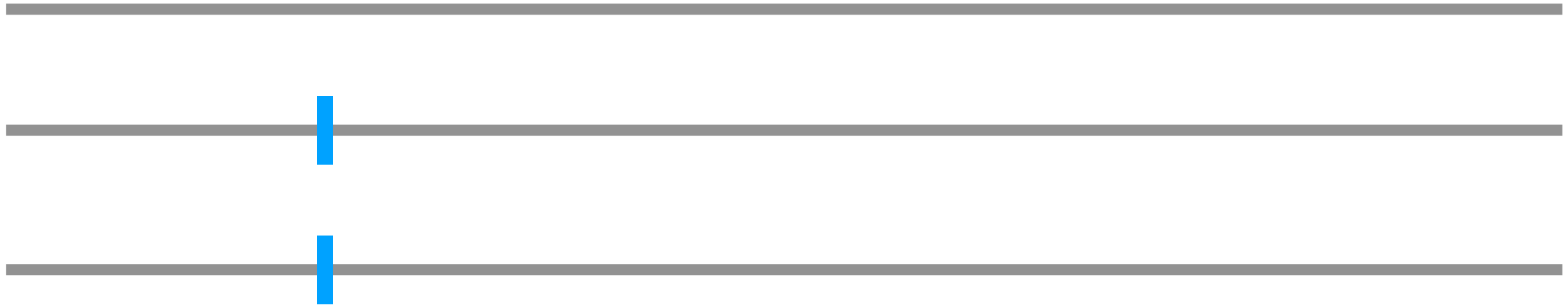
# Mutations accumulate randomly



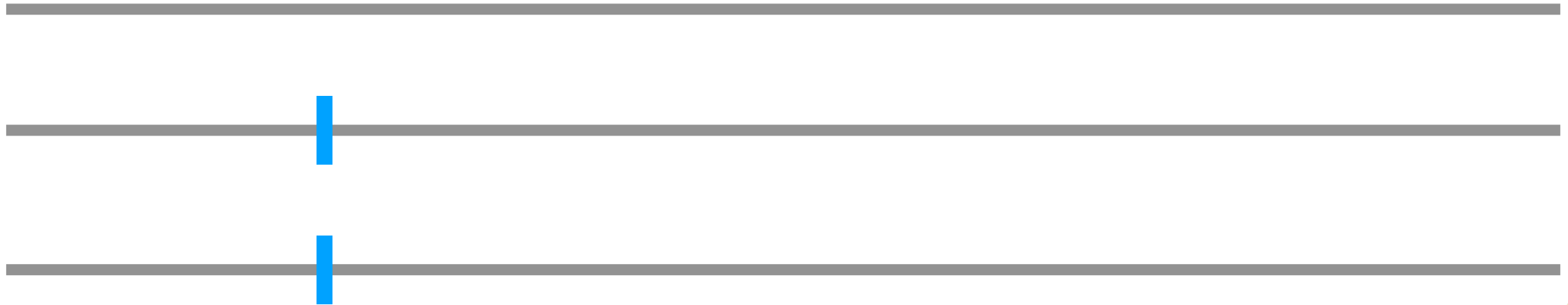
# Mutations accumulate randomly



# Mutations accumulate randomly



# Mutations accumulate randomly





# Mutations accumulate randomly



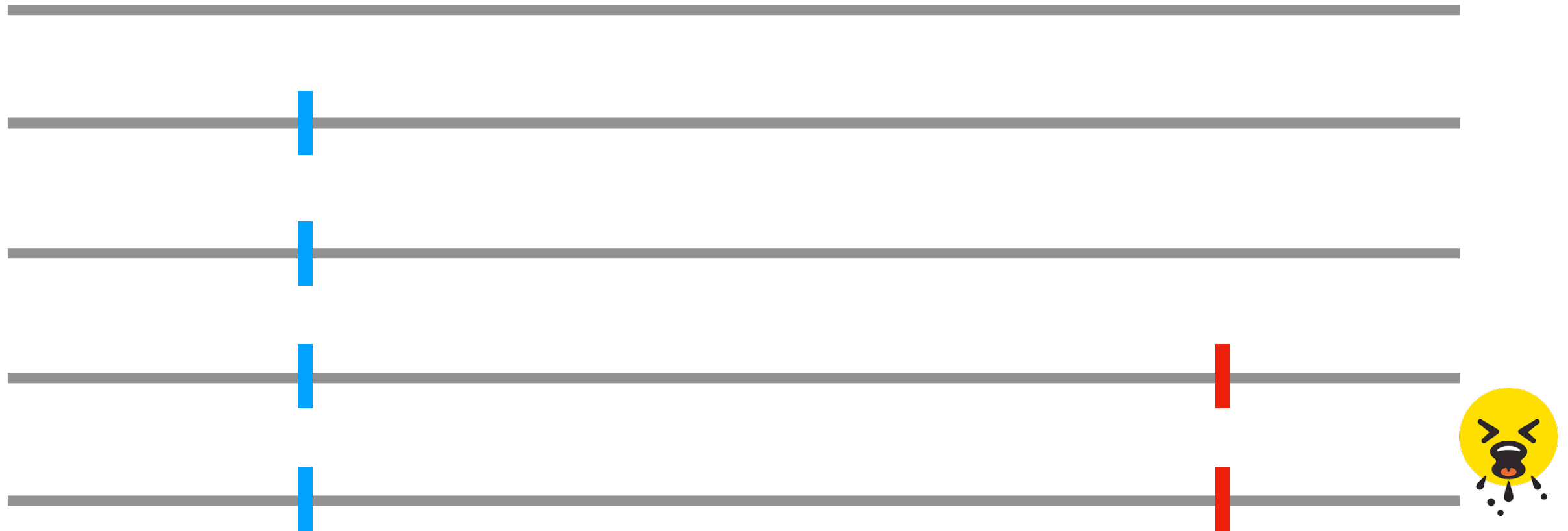
# Mutations accumulate randomly



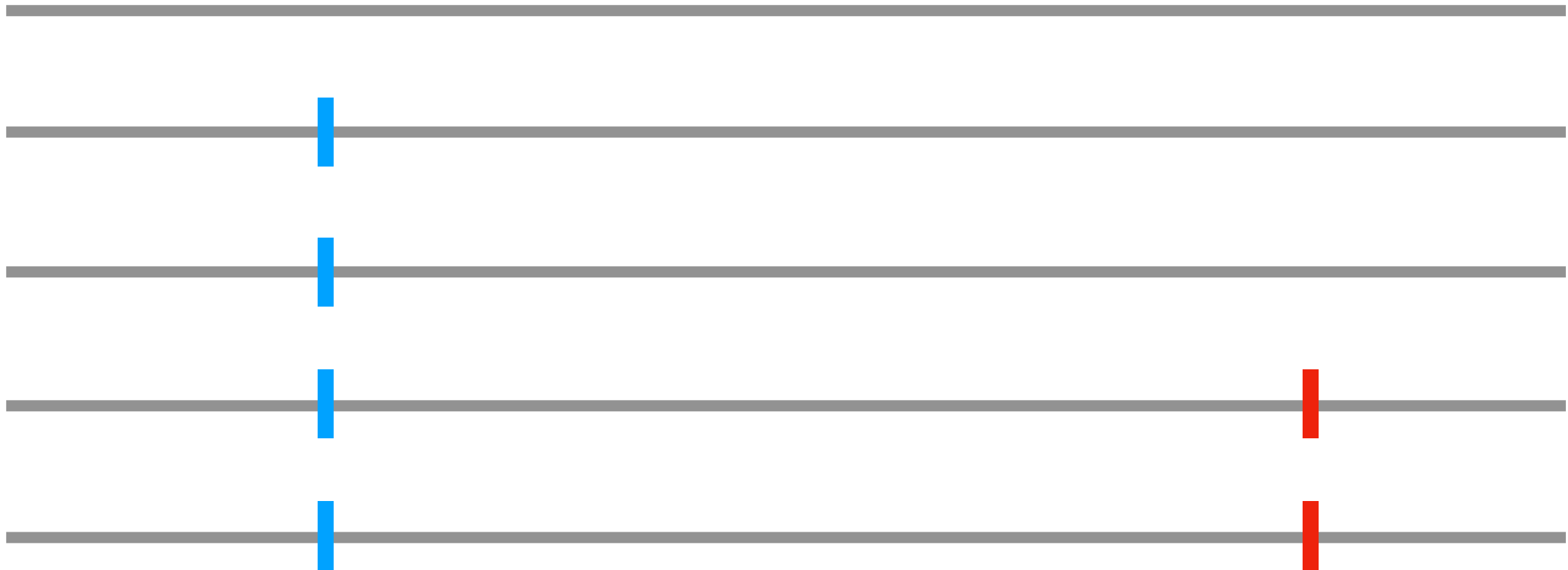
# Mutations accumulate randomly



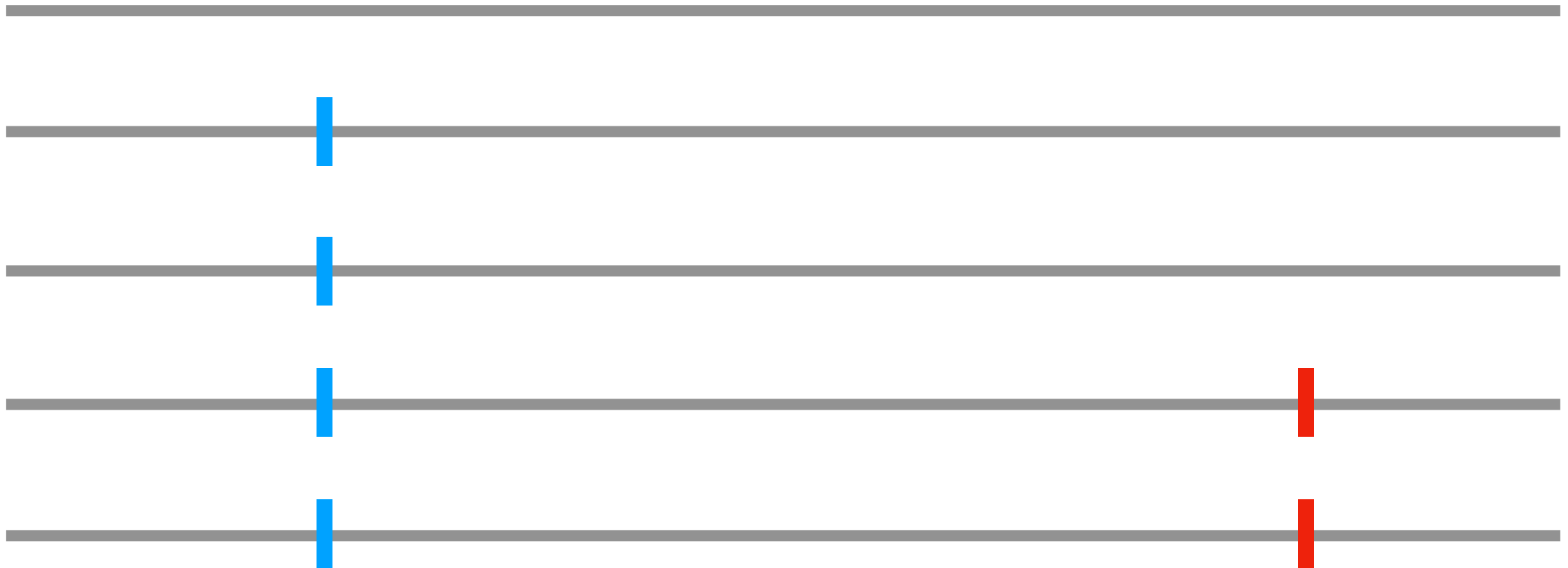
# Mutations accumulate randomly



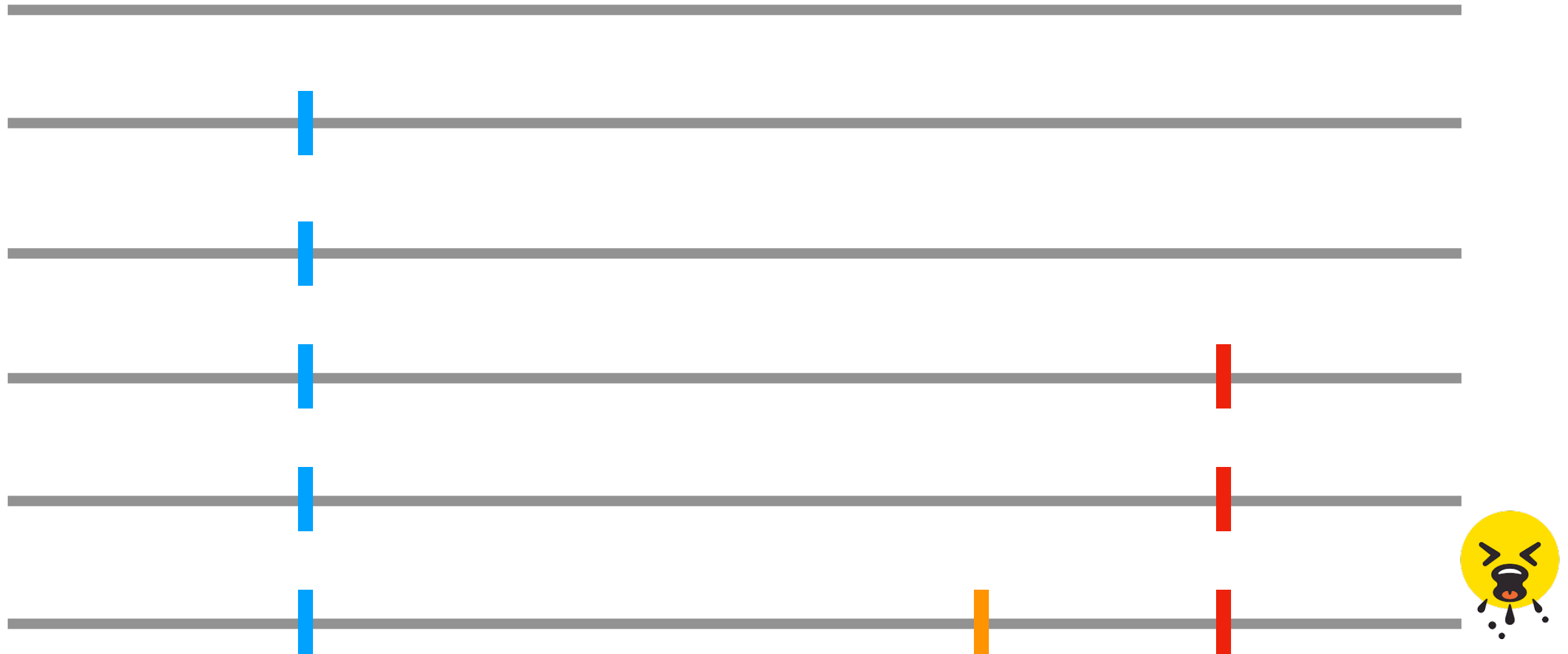
# Mutations accumulate randomly



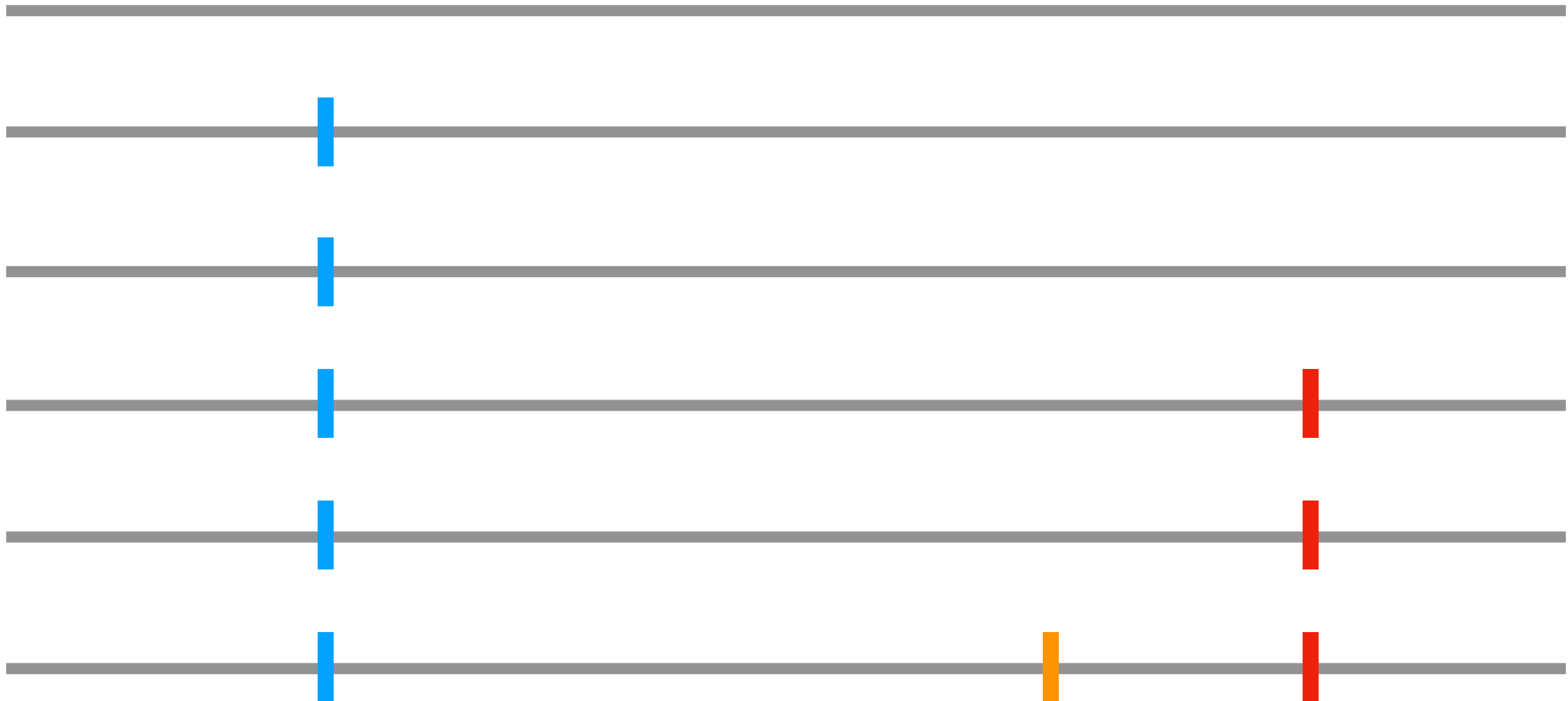
# Mutations accumulate randomly



# Mutations accumulate randomly

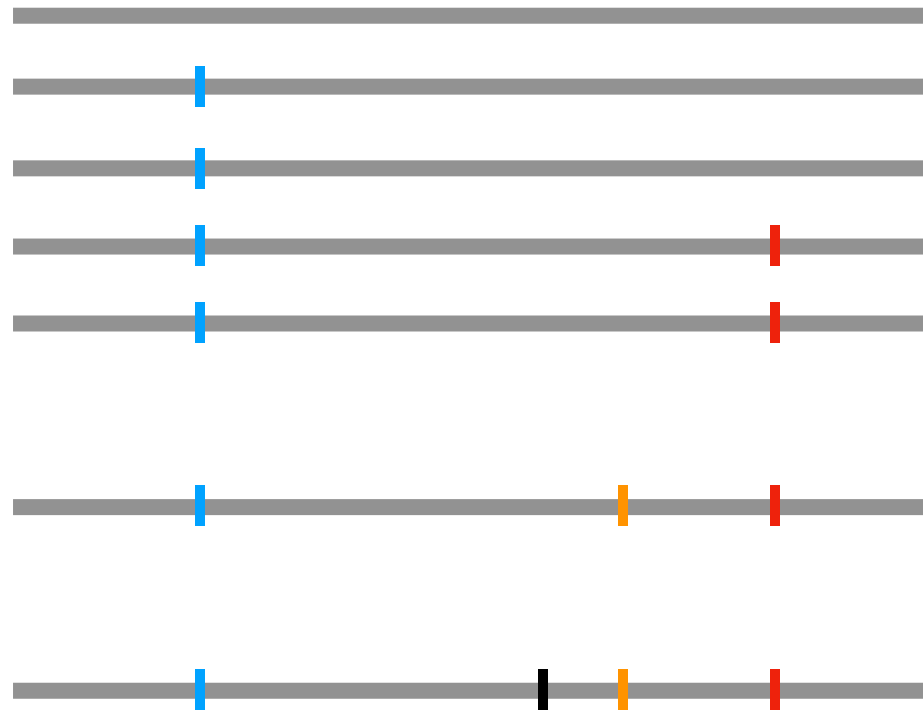


# Mutations accumulate randomly

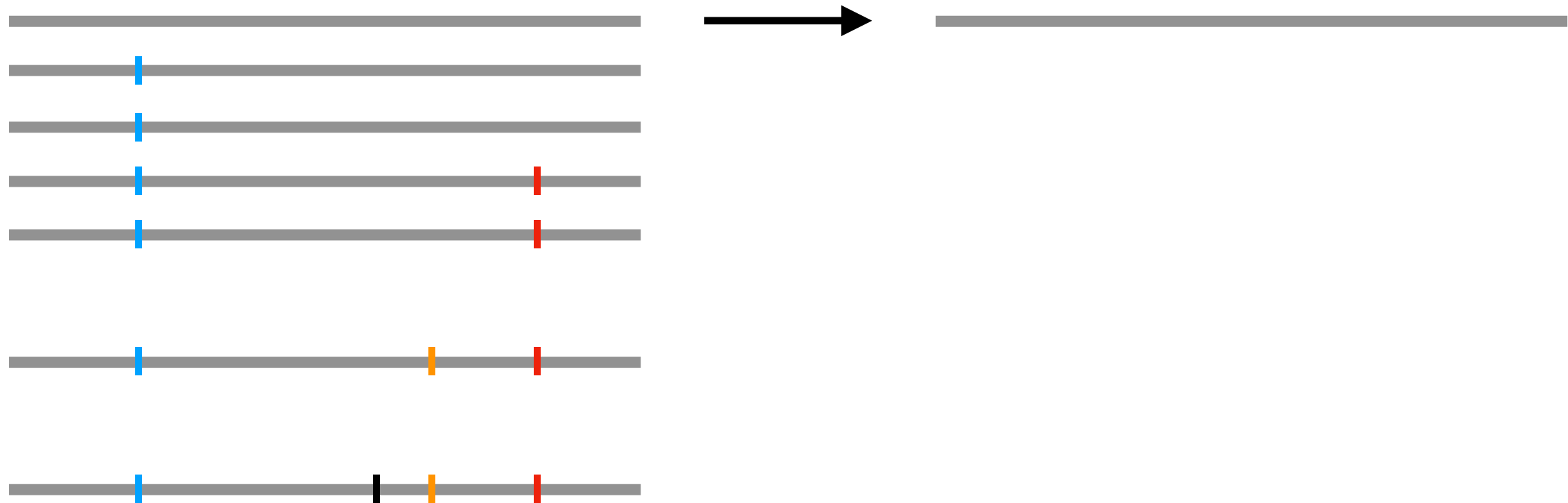




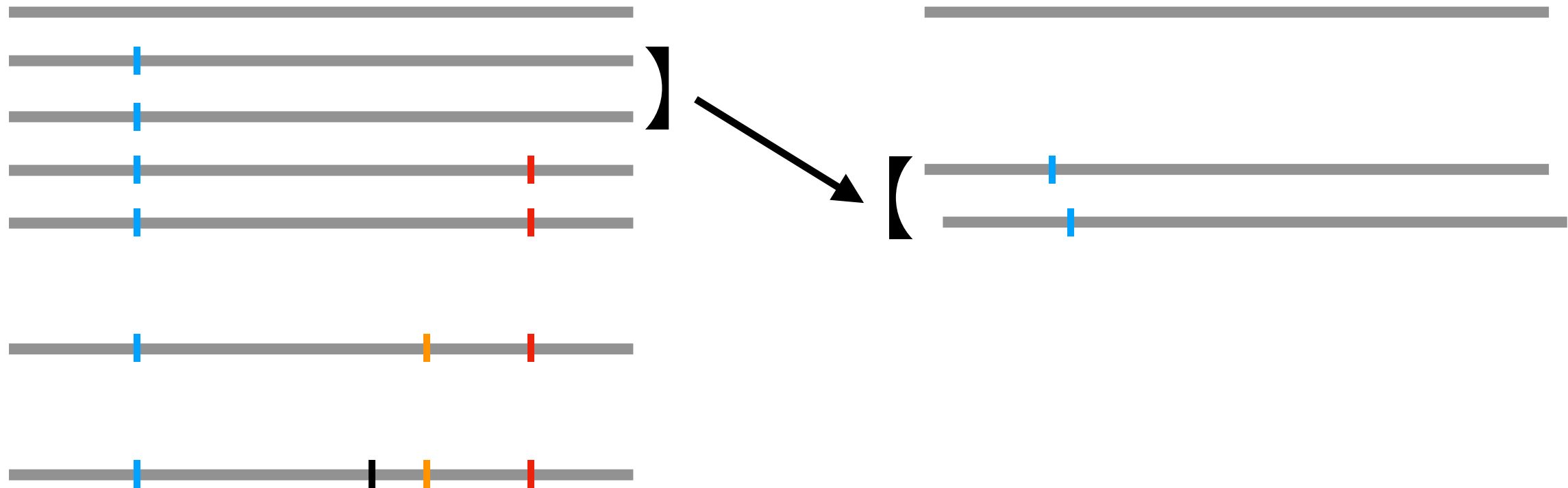
# More "fit" viruses have more descendants (cases)



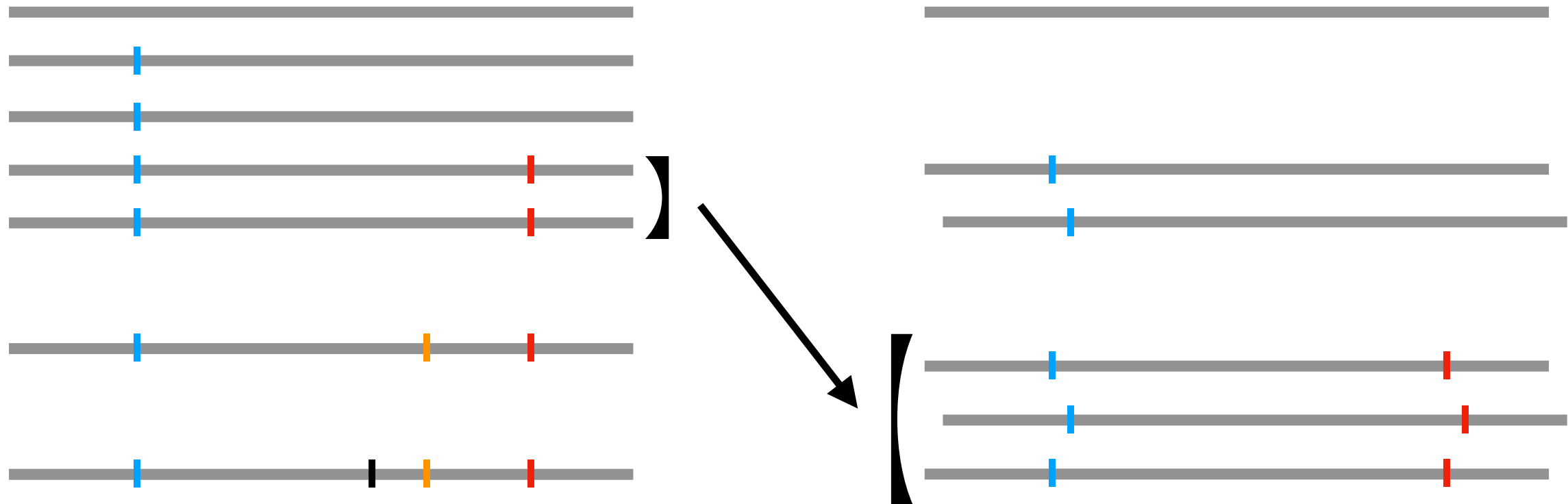
# More "fit" viruses have more descendants (cases)



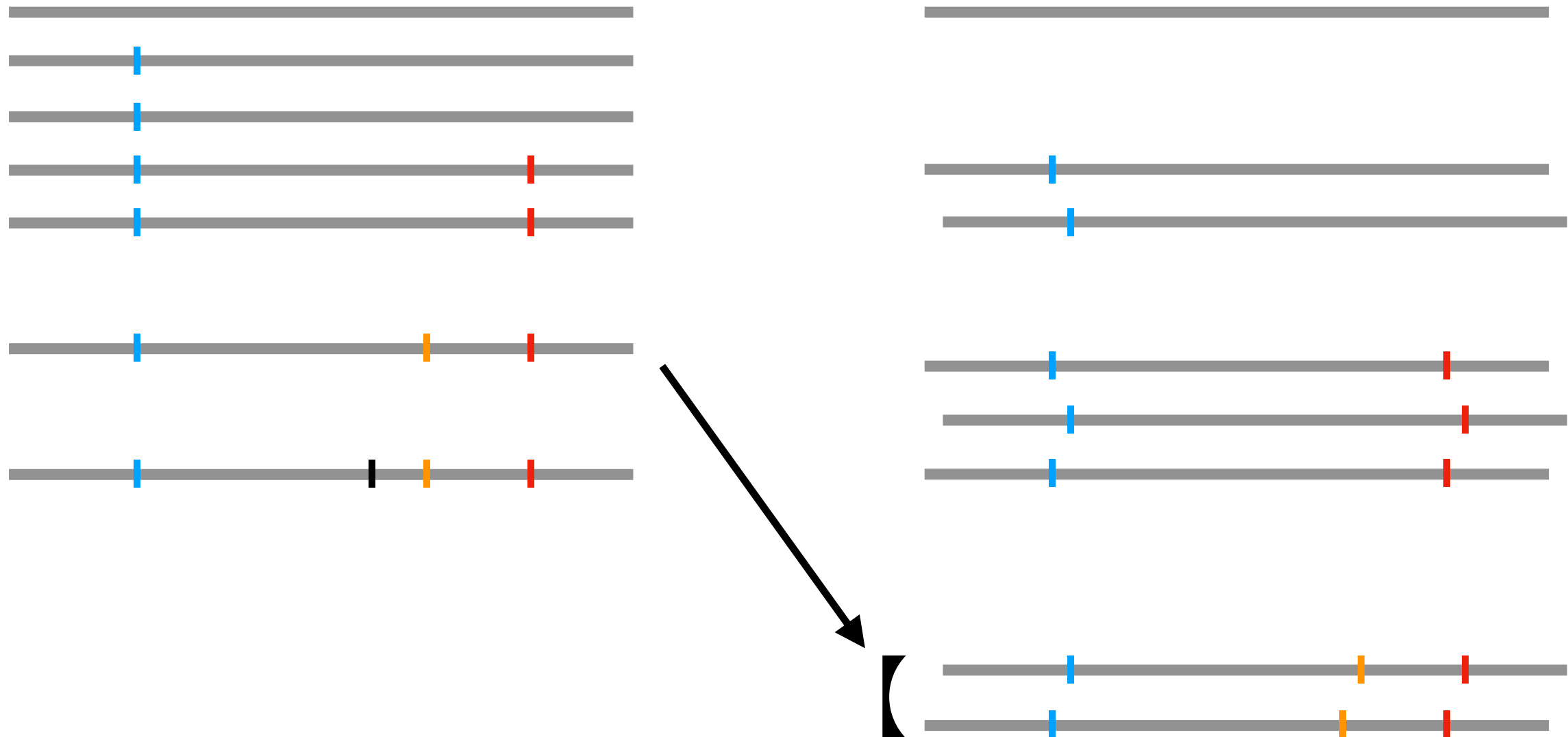
# More "fit" viruses have more descendants (cases)



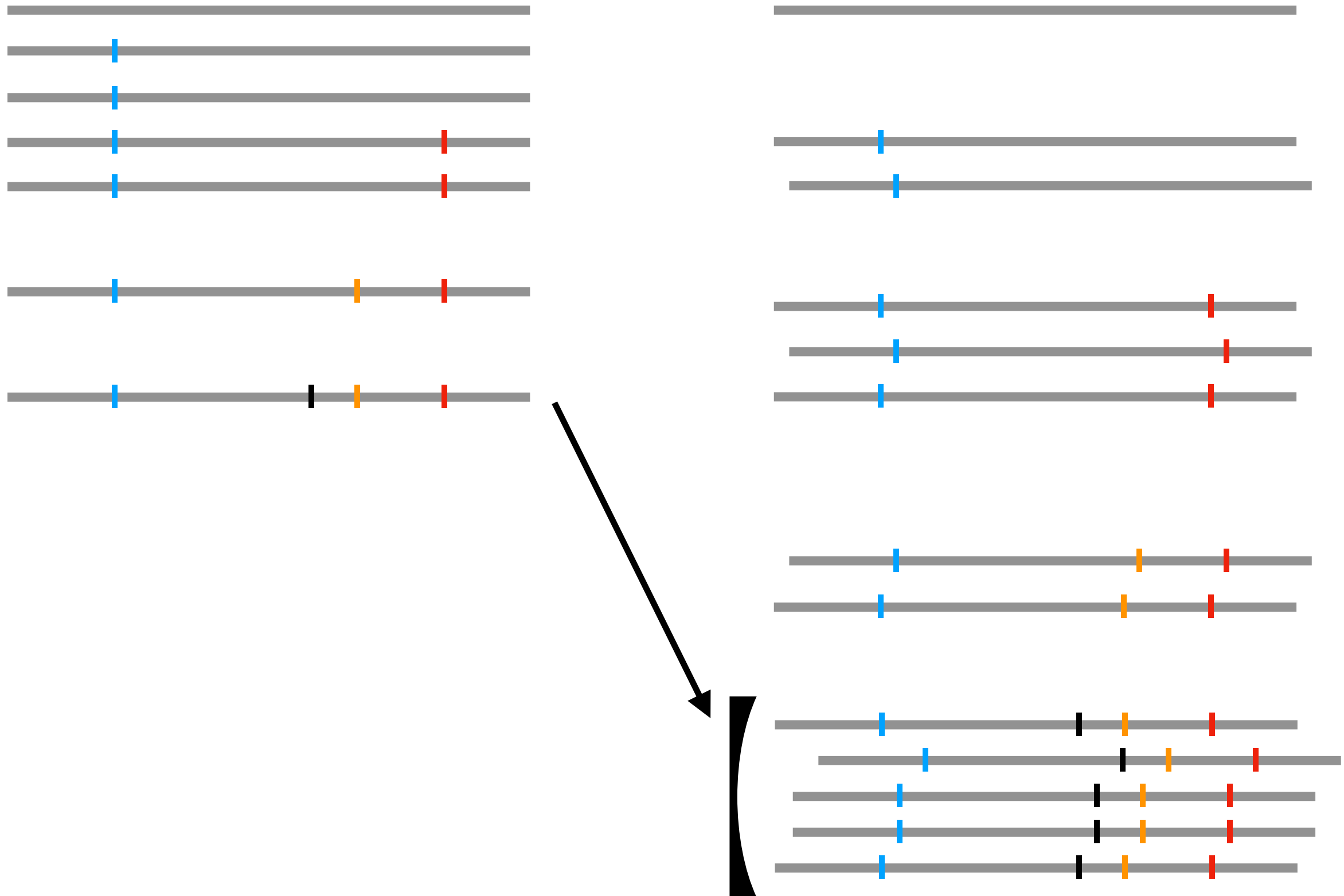
# More "fit" viruses have more descendants (cases)



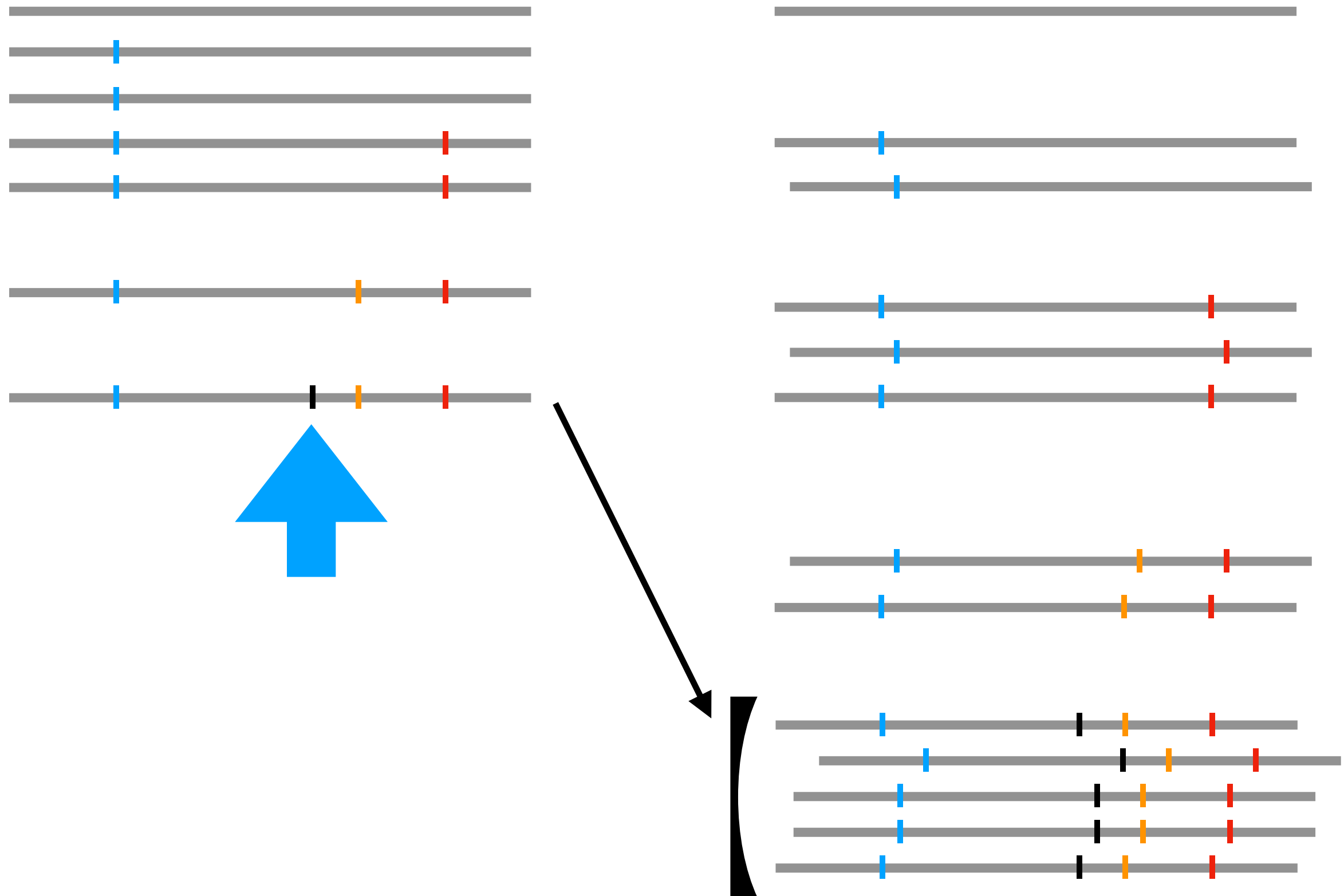
# More "fit" viruses have more descendants (cases)



# More "fit" viruses have more descendants (cases)



# More "fit" viruses have more descendants (cases)



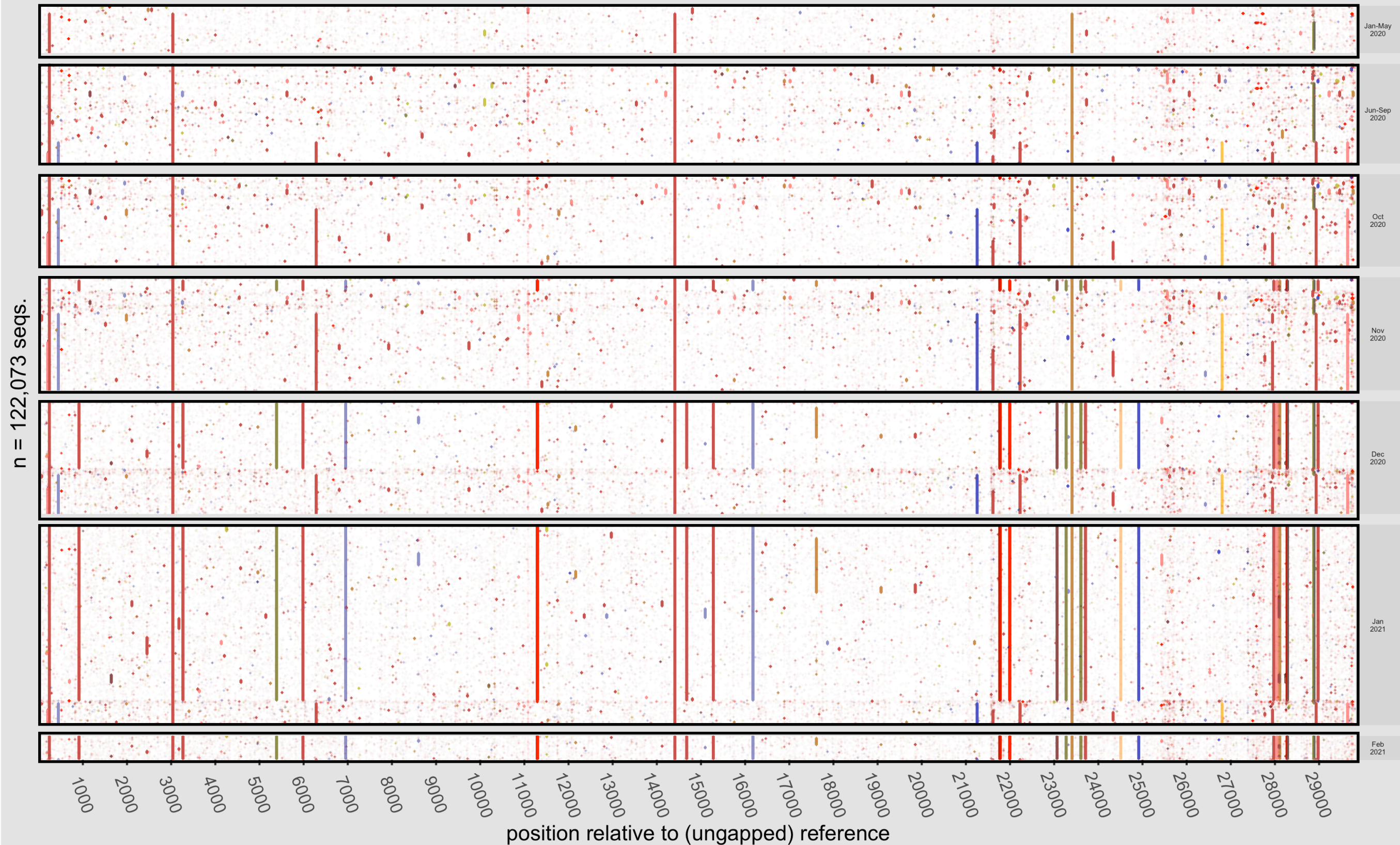
# The rise of the "UK" Variant

[illegible]



# The rise of the "UK" Variant

gisaid.NEARCOMP.England (ref: NC\_045512\_common\_boundaries)

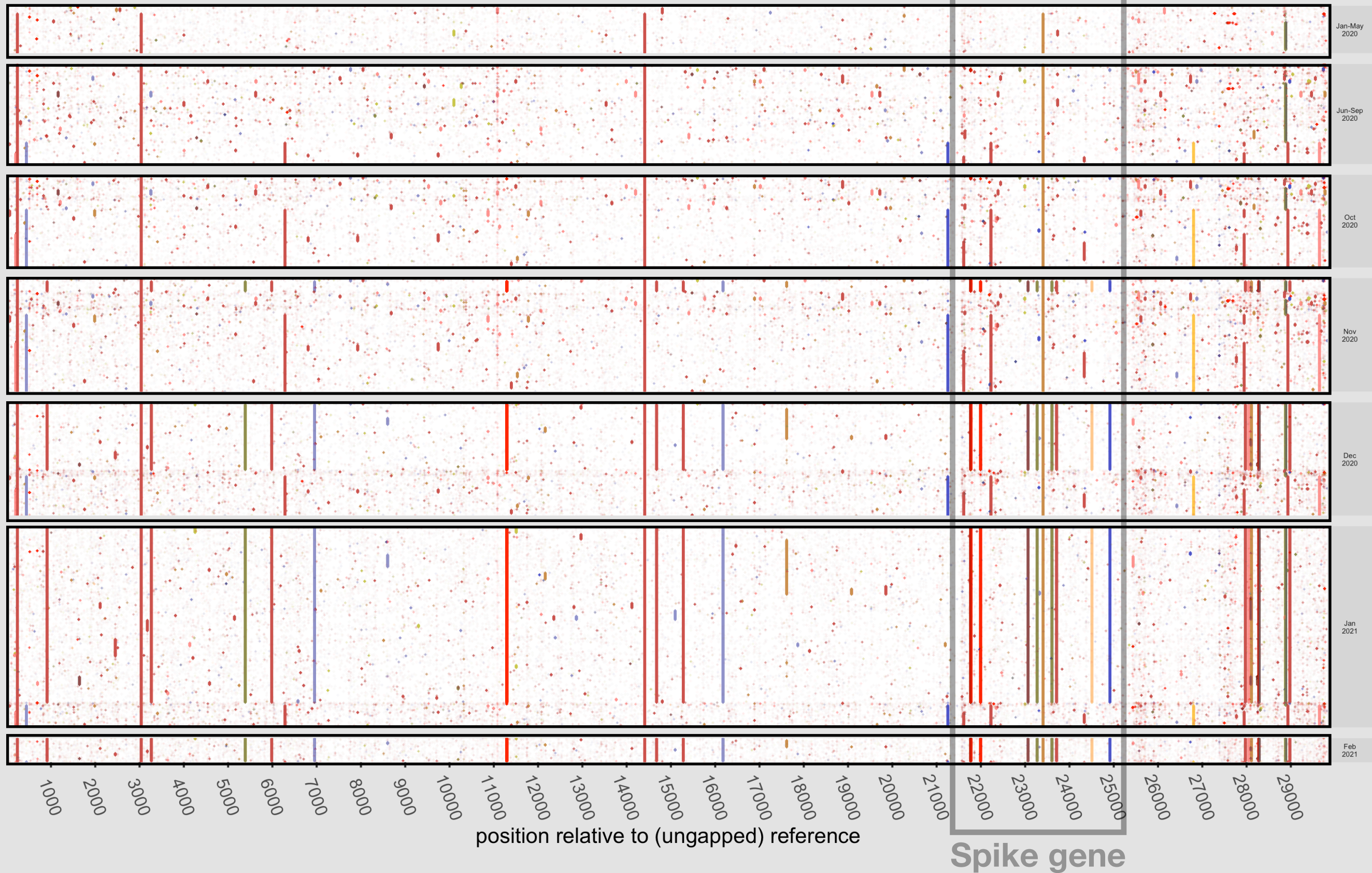




# The rise of the "UK" Variant

gisaid.NEARCOMP.England (ref: NC\_045512\_common\_boundaries)

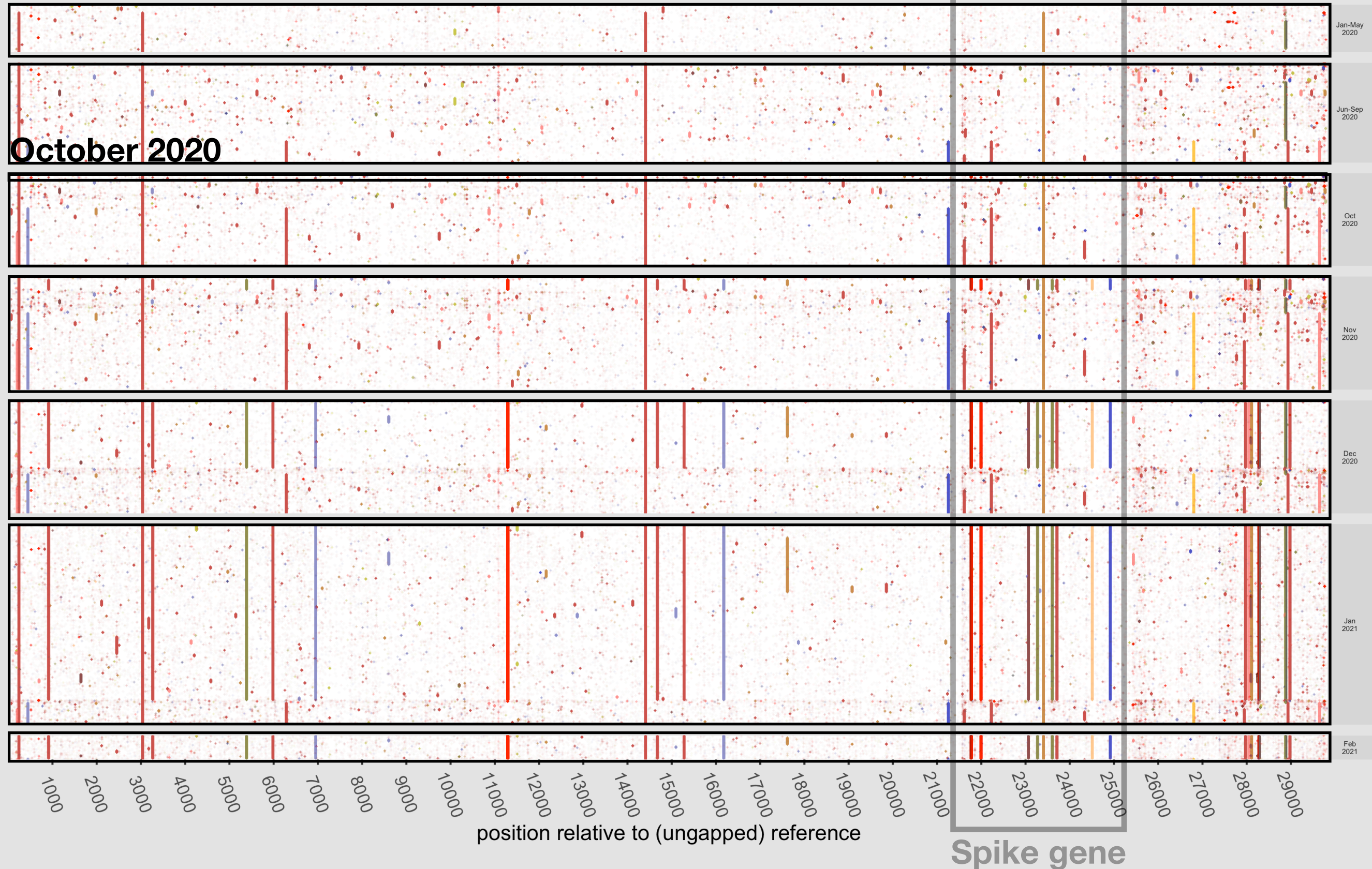
n = 122,073 seqs.





# The rise of the "UK" Variant

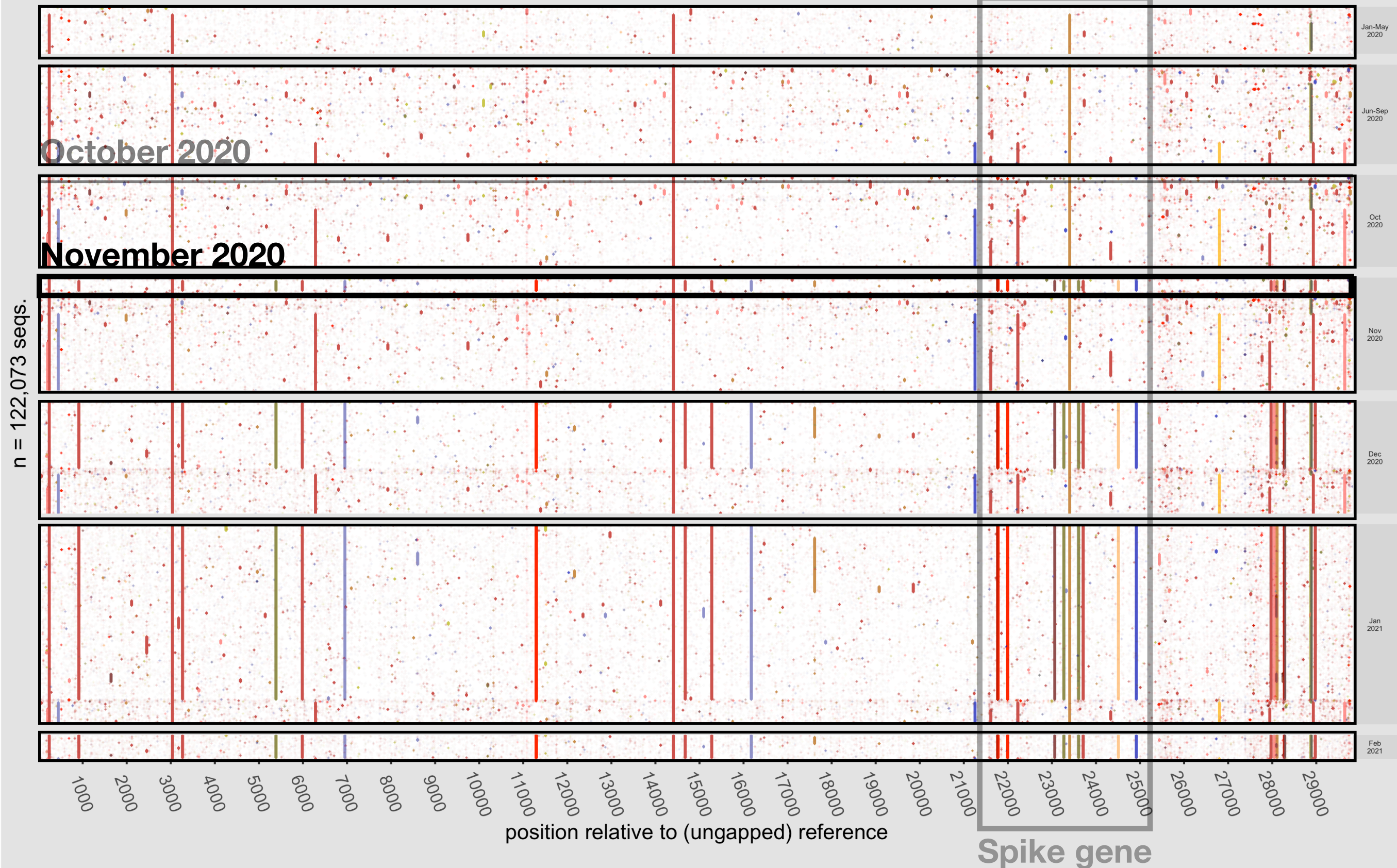
gisaid.NEARCOMP.England (ref: NC\_045512\_common\_boundaries)





# The rise of the "UK" Variant

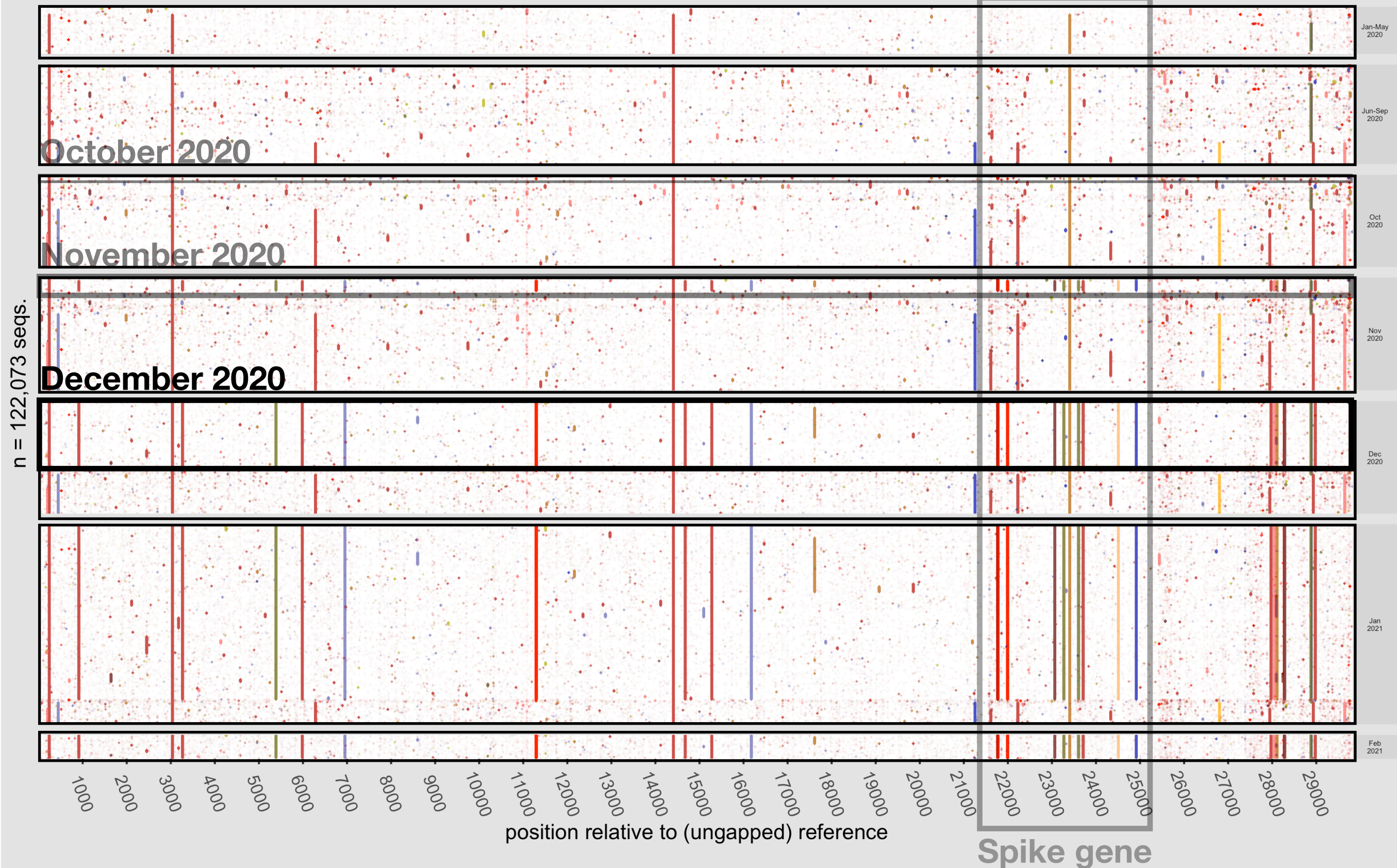
gisaid.NEARCOMP.England (ref: NC\_045512\_common\_boundaries)





# The rise of the "UK" Variant

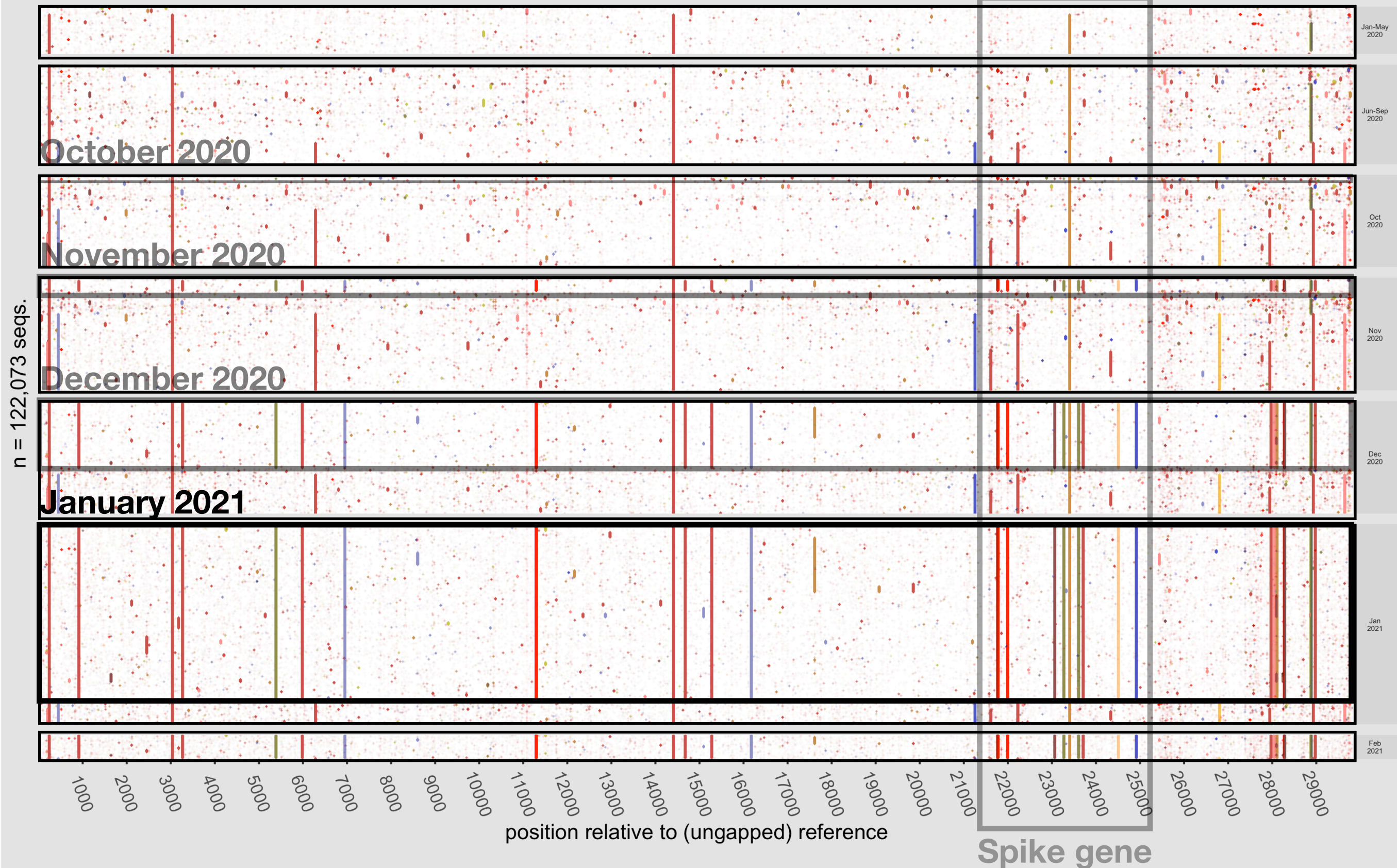
gisaid.NEARCOMP.England (ref: NC\_045512\_common\_boundaries)





# The rise of the "UK" Variant

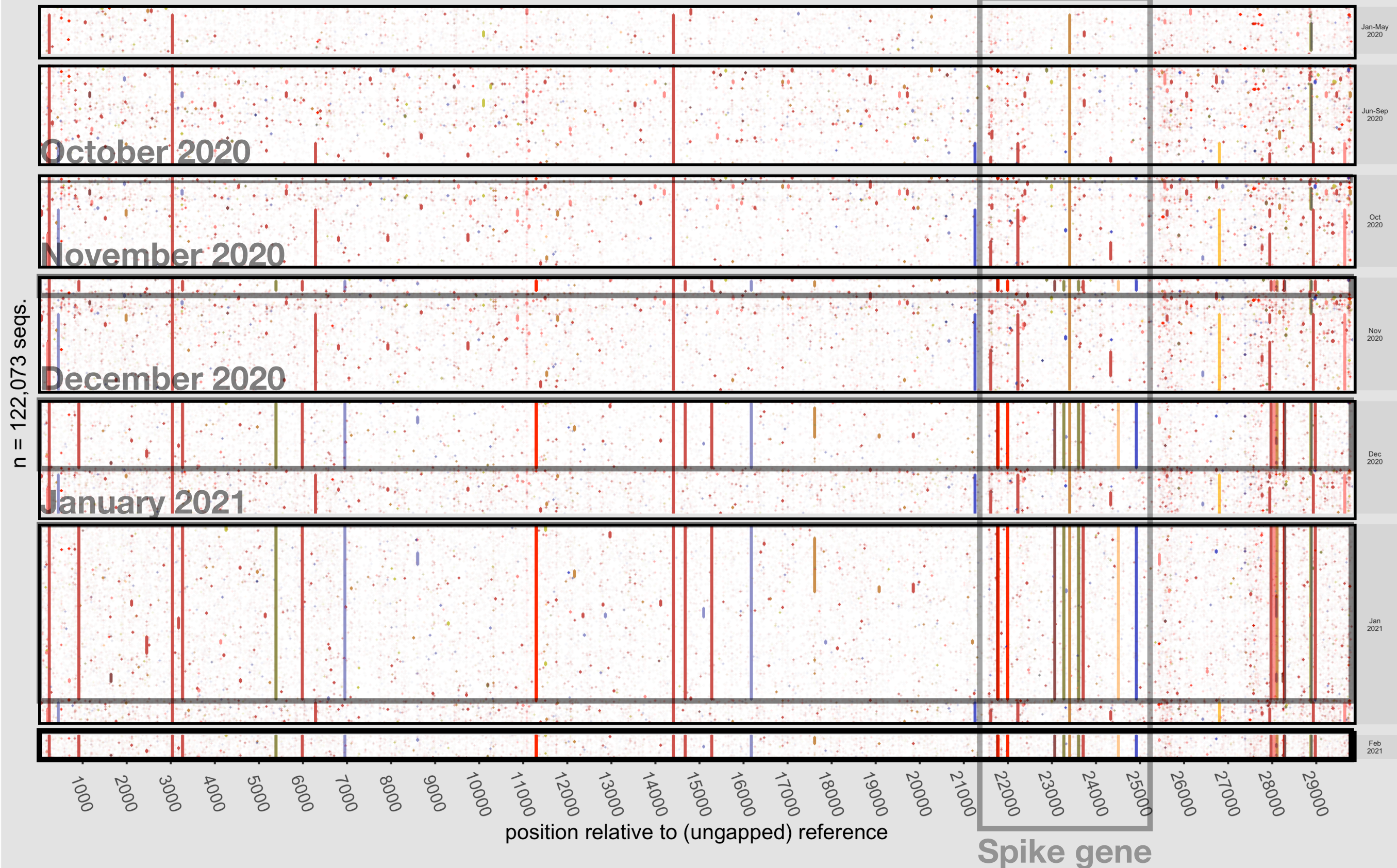
gisaid.NEARCOMP.England (ref: NC\_045512\_common\_boundaries)





# The rise of the "UK" Variant

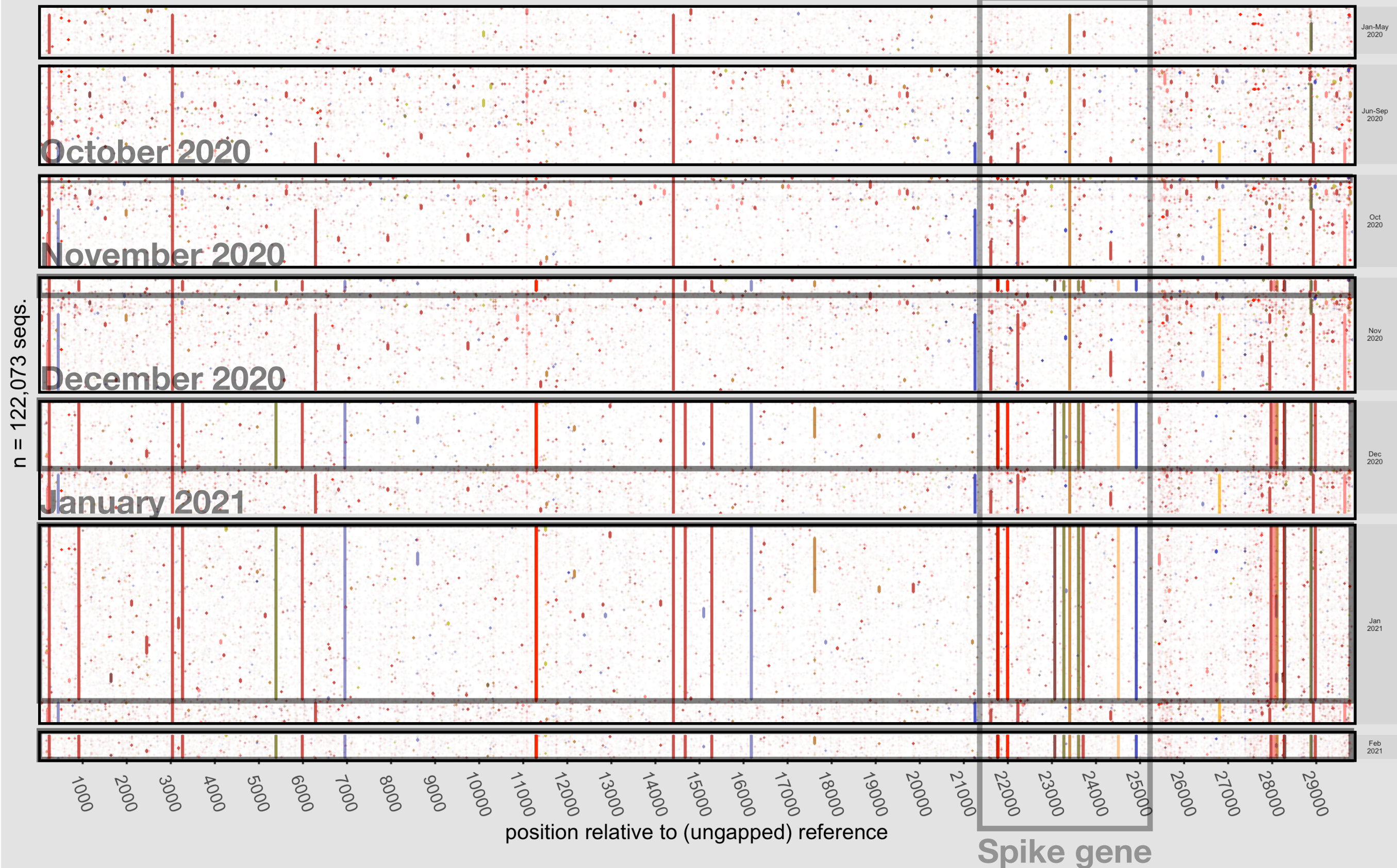
gisaid.NEARCOMP.England (ref: NC\_045512\_common\_boundaries)



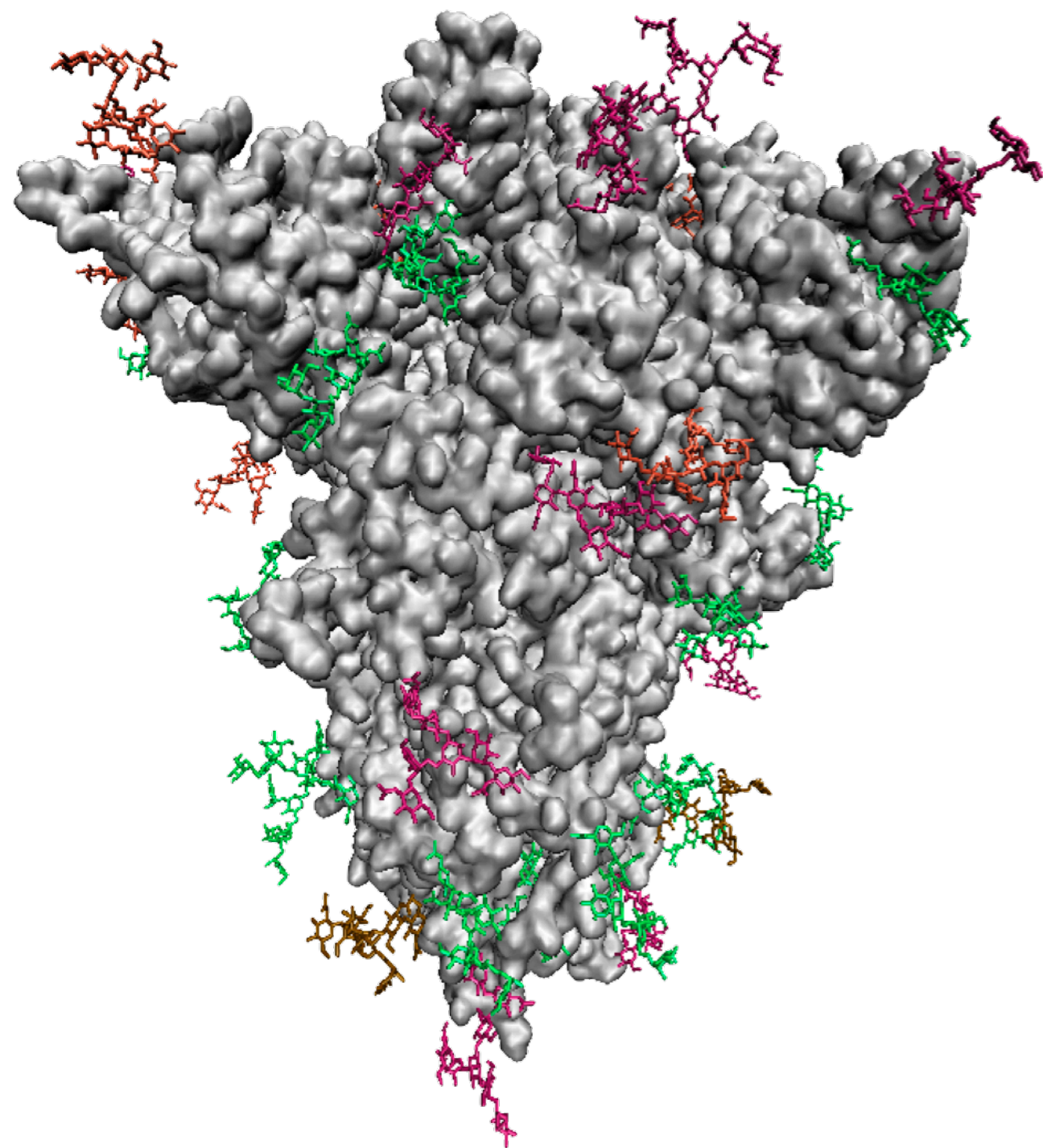


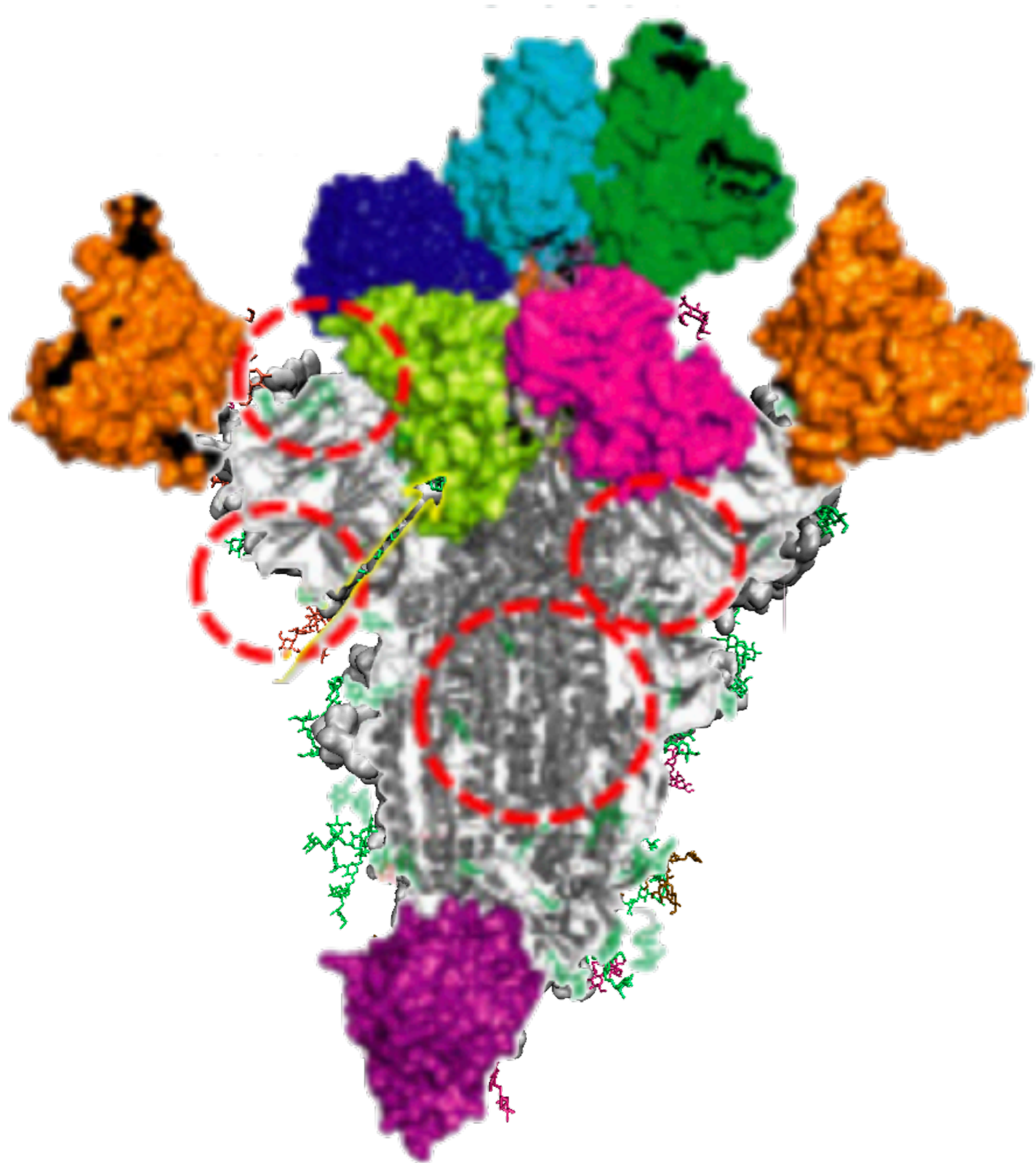
# The rise of the "UK" Variant

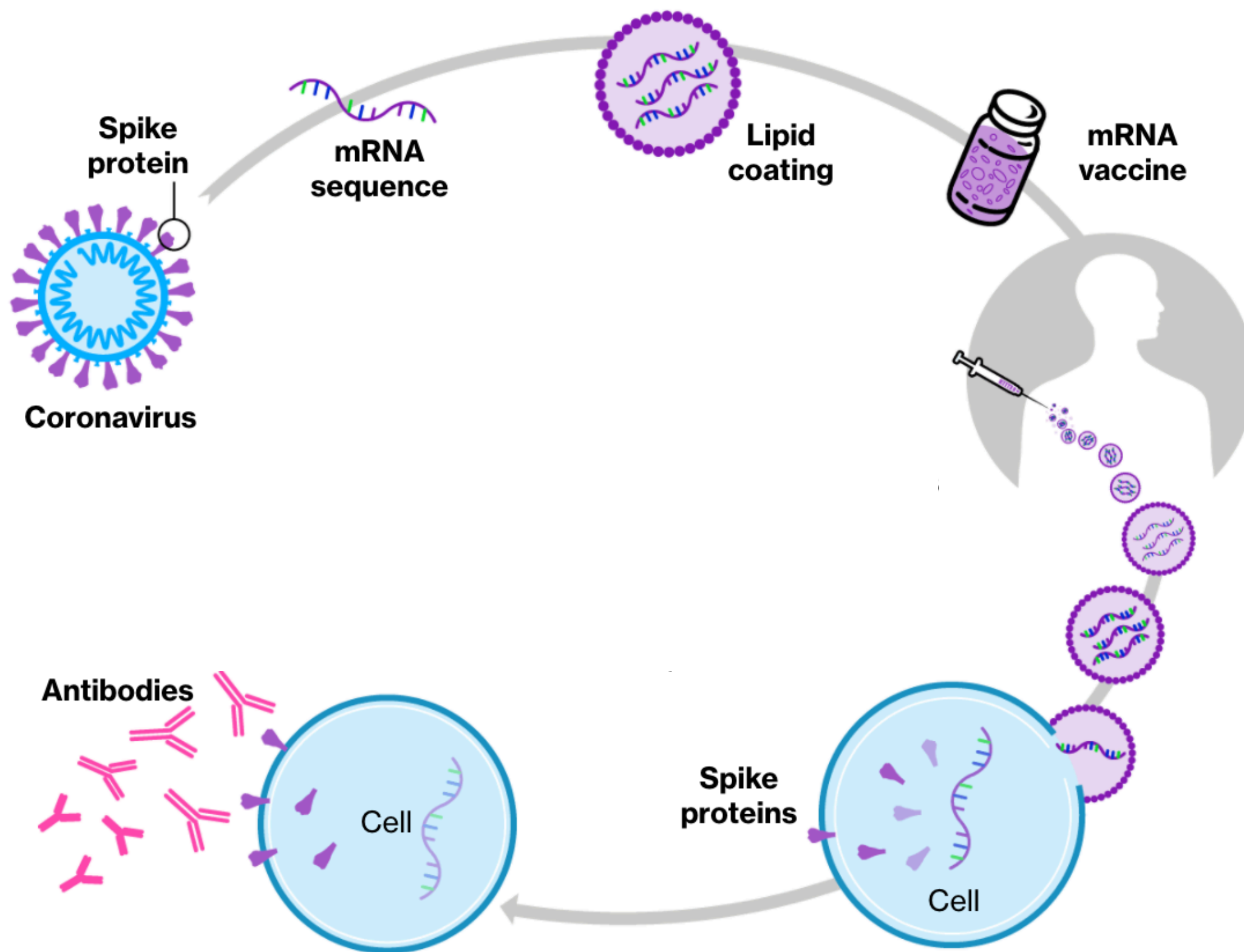
gisaid.NEARCOMP.England (ref: NC\_045512\_common\_boundaries)





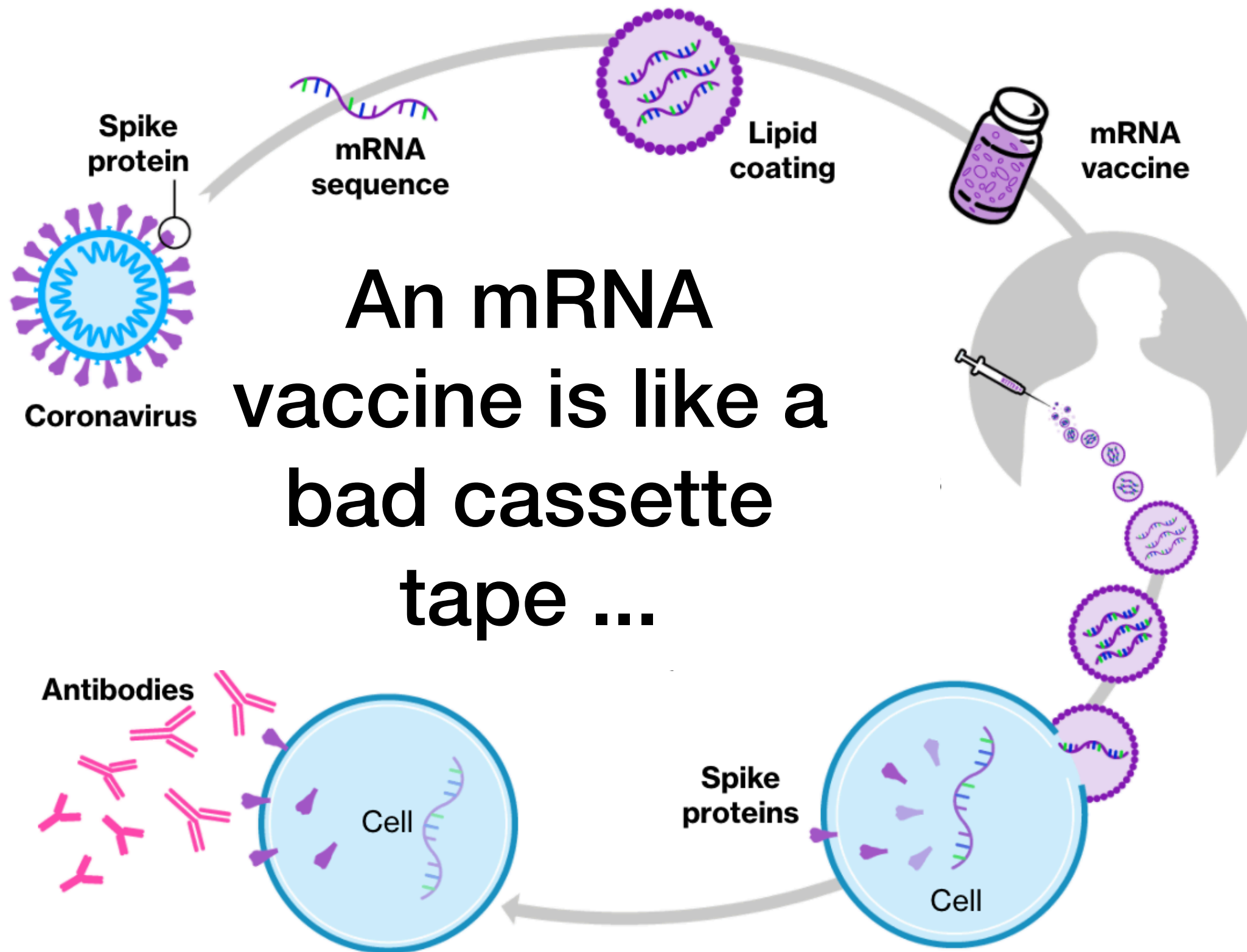


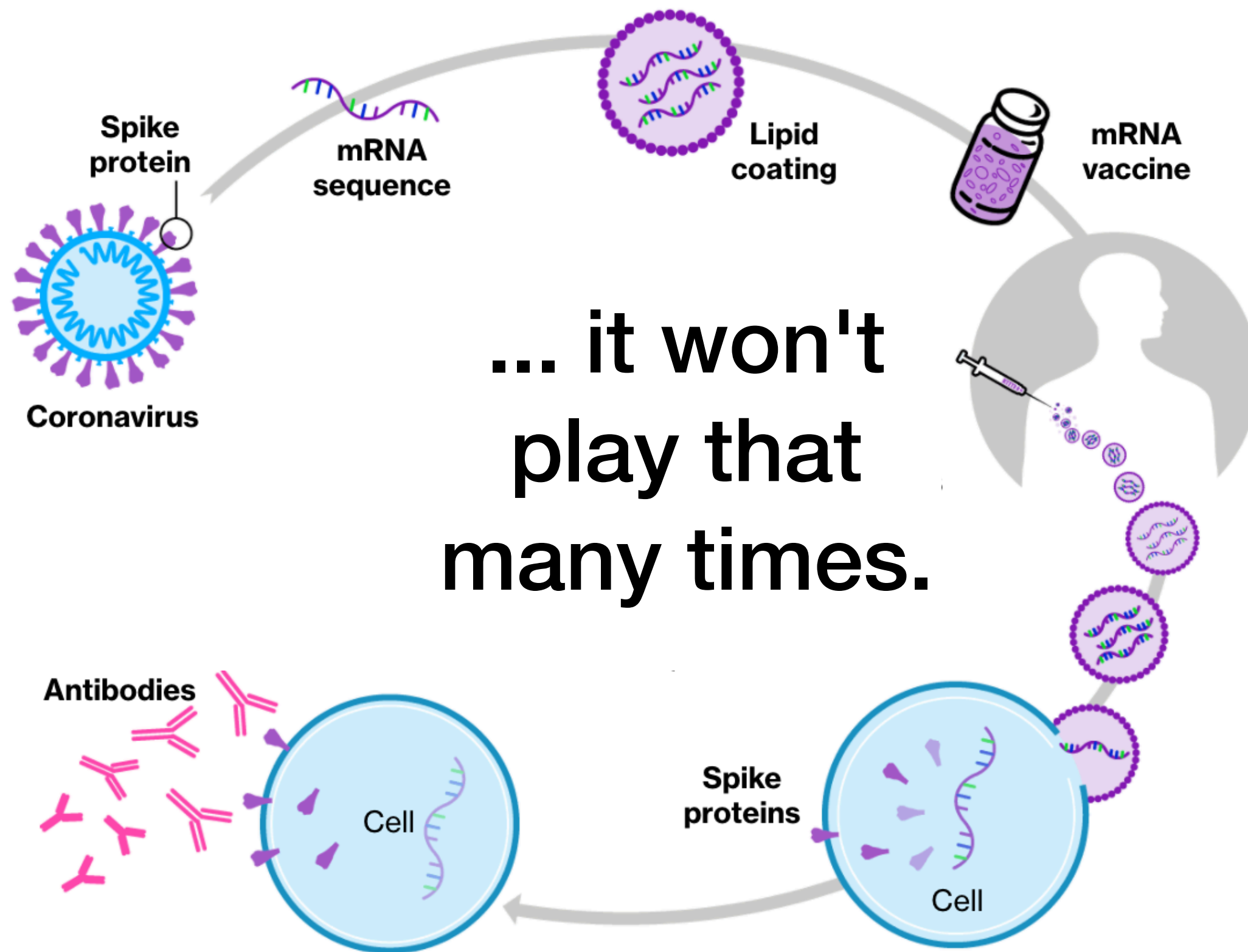


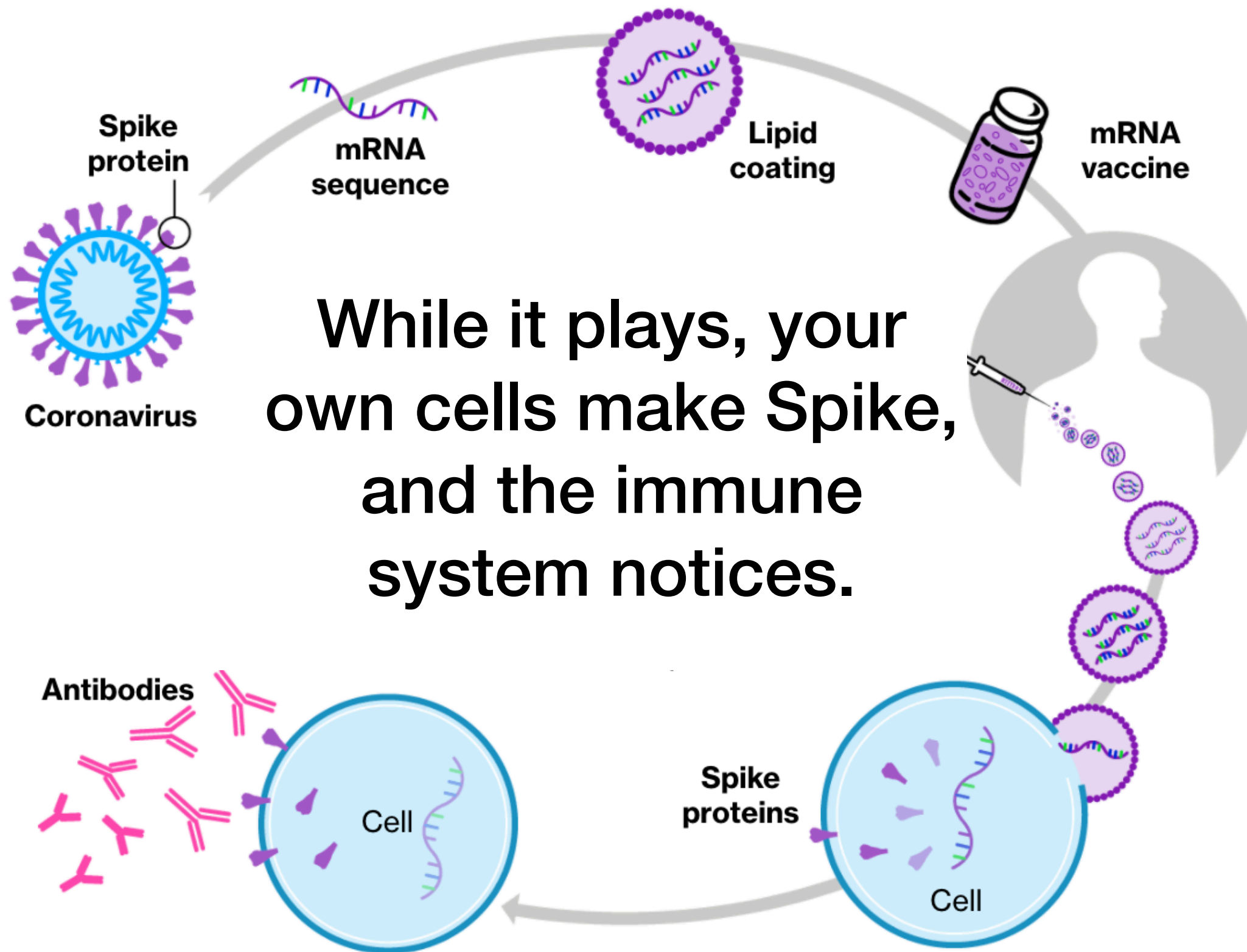


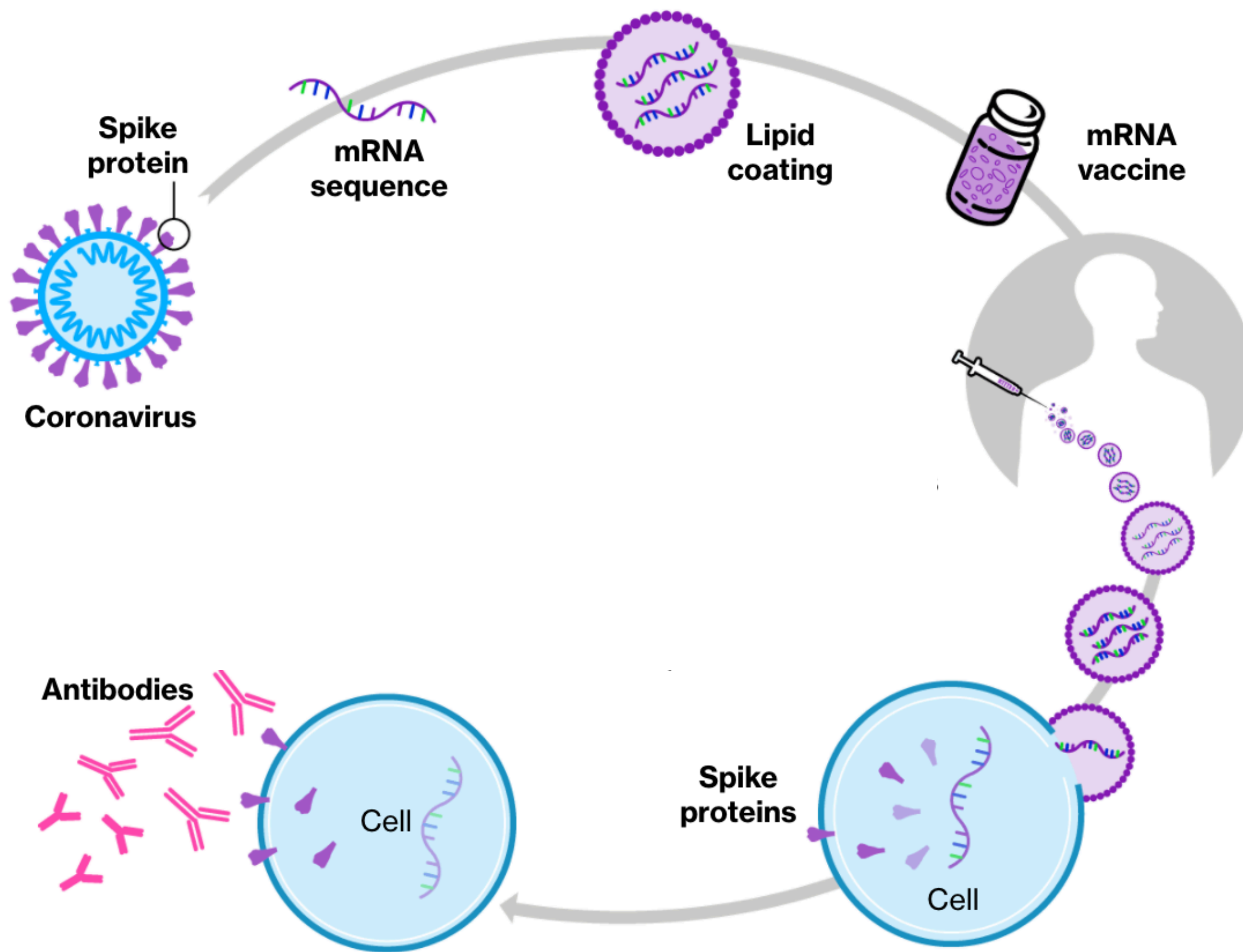
Sources: Pfizer, Bloomberg research











Sources: Pfizer, Bloomberg research

# Variant lineages of concern

**"UK Variant": 20I/501Y.V1, VOC 202012/01, or B.1.1.7**

- ▶ Little change in vaccine effectiveness
- ▶ More infectious
- ▶ More lethal
- ▶ Present in USA

**"South African": 20H/501Y.V2 or B.1.351**

- ▶ Significant decrease in vaccine effectiveness
- ▶ No large effect on disease
- ▶ Present in USA

**"Brazilian": P.1 or 20J/501Y.V3 or B.1.1.28**

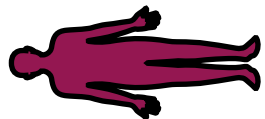
- ▶ May evade infection-induced immunity
- ▶ Possible increased disease severity



# Variants and vaccine effectiveness

Several of the vaccines are less effective against some of the new variants — but they still help!

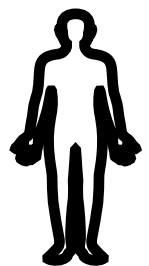
Symptoms and infectivity — *without* masks



Less spreading



Lots of spreading



No spreading

# Variants and vaccine effectiveness

Several of the vaccines are less effective against some of the new variants — but they still help!

Symptoms and infectivity — *without* masks



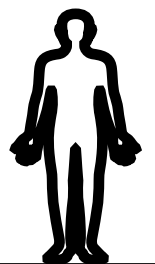
Really  
sick

Less spreading



mild  
symptoms

Lots of spreading



uninfected

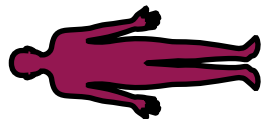
No spreading

# Variants and vaccine effectiveness

Several of the vaccines are less effective against some of the new variants — but they still help!

Symptoms and infectivity — *without* masks

Unvaccinated



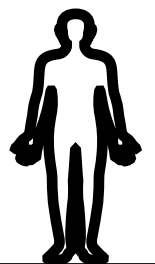
Really  
sick

Less spreading



mild  
symptoms

Lots of spreading



uninfected

No spreading

# Variants and vaccine effectiveness

Several of the vaccines are less effective against some of the new variants — but they still help!

## Symptoms and infectivity — *without* masks

Unvaccinated



Vaccinated (vaccine-matched)



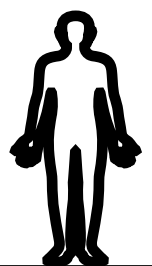
Really  
sick

Less spreading



mild  
symptoms

Lots of spreading



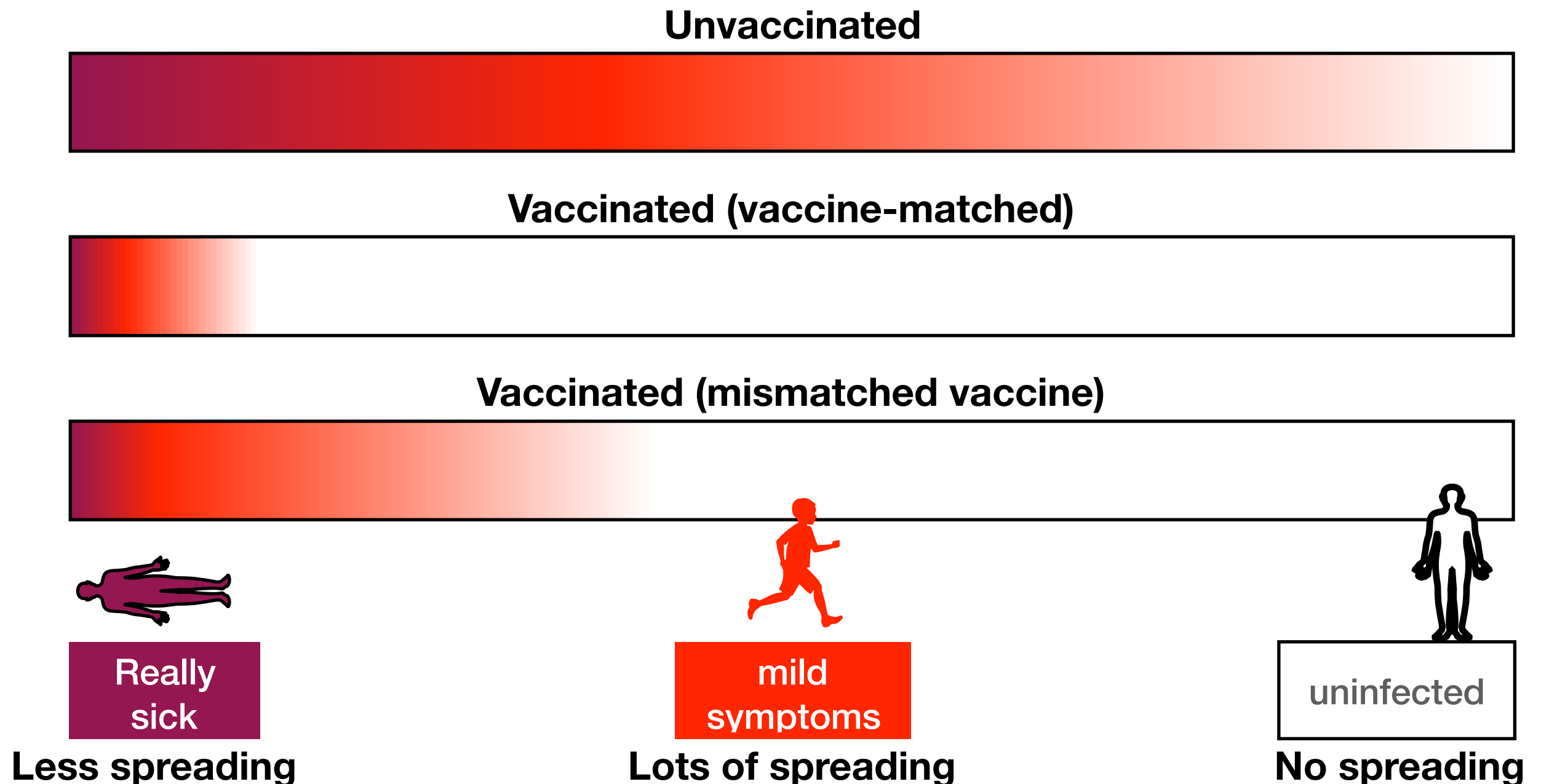
uninfected

No spreading

# Variants and vaccine effectiveness

Several of the vaccines are less effective against some of the new variants — but they still help!

## Symptoms and infectivity — *without* masks



# Masking and distancing are still critical

**Infectivity — with masks**

# Masking and distancing are still critical

**Infectivity — with masks**

**Unvaccinated**



# Masking and distancing are still critical

## Infectivity — with masks

Unvaccinated



Vaccinated (vaccine-matched)





# Masking and distancing are still critical

## Infectivity — with masks

Unvaccinated



Vaccinated (vaccine-matched)



Vaccinated (mismatched vaccine)



# What can we (LANL) and we (the public) do?

## **LANL — the scientists**

- ▶ Tracking mutations for updated vaccines
- ▶ Advanced vaccine concepts
  - conserved regions
  - multiple variants
  - different immune mechanisms

## **You — the citizens**

- ▶ Keep the cases down -- reduce opportunities for mutation and recombination (fewer new variants)
- ▶ the next few months will be a race between vaccination and mutation -- let's make sure the good guys win.

# Thanks

## LANL Colleagues

- ▶ **Bette Korber**
- ▶ Hyejin Yoon
- ▶ Werner Abfalterer
- ▶ Brian Foley
- ▶ Elena Giorgi
- ▶ Tanmoy Bhattacharya

## Experimental collaborators

- ▶ David Montefiori (Duke)
- ▶ Erica O. Saphire (Scripps)
- ▶ additional vaccine makers



- ▶ The Global SARS-CoV-2 sequence database
- ▶ The clinical teams collecting sequences

**You, for your  
attention.**